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FIELD MANUAL

FIELD ARTILLERY COMMUNICATIONS

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HEADQUARTERS, DEPARTMENT OF THE ARMY
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FIELD MANUAL }
No. 6-10

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 6 March 1970

FIELD ARTILLERY COMMUNICATIONS

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CHAPTER 1

INTRODUCTION

1. Purpose and Scope

This manual is a guide for commanders, staff officers, and personnel concerned with field artillery communications. The purpose of the manual is to provide, in a detailed but nontechnical explanation, the basic knowledge required in the application and employment of efficient field artillery communications.

2. Application

a. Unless otherwise specified, this manual is equally applicable to nuclear and nonnuclear warfare.

b. This manual should be used in conjunction with appropriate references indicated throughout this manual and in appendix A.

3. Changes or Comments

Users of this manual are encouraged to submit

recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commandant, U.S. Army Field Artillery School, ATTN: AKPSIAS-PL-FM, Fort Sill, Oklahoma 73503.

4. References

Appropriate publications pertaining to communications are listed in appendix A.

5. Symbols

Symbols used in this manual are described in appendix B.

CHAPTER 2

GENERAL COMMUNICATION REQUIREMENTS

Section I. GENERAL

6. Introduction

The ability of field artillery to render effective fire support depends on efficient communication. The field artillery commander must rely on his communication system in controlling elements of his command, in gathering information and distributing intelligence, and in coordinating the fires of his units. Responsibility for communication rests with the commander at each echelon. The commander exercises this responsibility through his staff communication officer, who prepares communication plans and orders, directs and supervises the installation, operation, and maintenance of the communication system. The training of organic personnel in the use of the various communication means is also the responsibility of the communication officer. In addition, he supervises communication security within the unit, assumes responsibility for the on-line and off-line cryptographic equipment, and supervises the electronic countermeasures activities of the unit.

7. Area Communication Systems

The command and area communication systems, installed by the Signal Corps, are used by field artillery units to augment field artillery communication systems and to provide an alternate means of communication. The area system offers a means for expeditiously establishing a wire network between field artillery elements when the length of lines required is so great that it is beyond the capabilities of the units to establish or maintain these lines. When the area system is used primarily for handling logistic and administrative traffic, field artillery units sometimes use the

system on a common-user basis. However, when the field artillery uses the area system for transmitting fire control traffic, sole-user circuits are required. The communication officer must be provided with early information of impending displacements in order to complete the necessary liaison with the agency responsible for displacing the communications system stations. For detailed information on the operation of communications systems, see appropriate field manuals in the 24 series.

8. Priority of Installation

In the establishment of a field artillery communication system, priority of installation is given to elements of the system concerned with fire support and fire direction. During movements and in the initial phase of occupation of position, reliance is placed on radio, but wire circuits are installed to parallel radio channels as soon as the situation permits.

9. Communication Planning

Communication planning is a continuous operation which begins with the commander's estimate of the situation. Communication planning is conducted concurrently with operational planning and is coordinated with the planning of the other staff officers. Communication planning follows the normal phases of staff planning described in FM 101-5. Communication plans include all details necessary to clarify and coordinate the communications/electronics activities of the affected units, such as wire recovery, radio retransmission, and sole-user circuits.

Section II. COMMUNICATION IN ASSEMBLY AREAS

10. General

In assembly areas, all echelons receive information concerning contemplated operations and

make their plans accordingly. Staff conferences are held for coordination of effort. Command posts are so organized that communication and personnel requirements may be held to a minimum.

11. Communication Activities in Assembly Areas

During the occupation of the concentration area, communication activities include the following:

- a.* Message centers are established and operated by each headquarters. Messengers are stationed at each message center and scheduled messenger service may be provided if the volume of traffic warrants.
- b.* Wire installations are held to a minimum within the concentration area.
- c.* Radio stations generally are silenced or re-

stricted in their operation except for warning nets. All radio sets are serviced and tested on channels prescribed for the planned operation by the SOI and SSI.

d. All communications equipment is inspected for operating condition and adequacy. Equipment shortages are replenished.

e. Training is continued and intensified. Emphasis is placed on requirements for the particular operation being planned.

f. Appropriate SOI items to include codes and authentication tables are distributed.

Section III. COMMUNICATION DURING MARCHES AND HALTS

12. Communication During Marches

a. During marches, communication facilities are used for column control and for contact with reconnaissance and security parties and with supported and higher units.

b. A march message center is established by each headquarters in one of the leading vehicles of the column. Normally, messengers are used between march units and within groups and serials of individual march units.

c. Wire communication is impractical; however, wire teams may precede the column to the future area to install wire communications, remain behind to recover wire from the old area, or both.

d. If radio communication is not prohibited for

security reasons, each field artillery unit operates on its command/fire direction channel. All vehicular radios operate on this channel for rapid dissemination of information and orders. Battalion commanders and separate battery commanders operate also in the next higher headquarters command/fire direction net, FM. Divisional light aircraft and field artillery reconnaissance and security parties maintain radio communication with the marching columns.

13. Communication During Halts

During temporary halts, communication is maintained as during the march. The use of messengers and radio (if not restricted) is continued.

Section IV. COMMUNICATION DURING THE ATTACK, REORGANIZATION, AND PURSUIT

14. General

a. When the supported force is committed, the field artillery must be ready to provide continuous fire support. Meteorological messages, warning orders, and other preparatory information are disseminated to the field artillery units as rapidly as possible. Consequently, the communication system must be developed rapidly in order for the field artillery to accomplish its mission.

b. In certain stages of an engagement, control of the field artillery may be decentralized. However, centralized control is resumed as soon as the situation permits to give the force commander a mass of firepower with which to influence the action.

15. Command Posts

In order to effect the necessary centralization of

command, field artillery command posts are established to coordinate all the field artillery fires of the force. Continuous communication is maintained between the command posts of the field artillery and the supported units. Initial installations may be expanded into more elaborate systems. For example, during the preparation for the attack of an organized position, enough time usually is available to permit a more detailed communication installation.

16. Displacement of Command Posts

a. Displacement of command posts follows the general plan indicated in FM 6-20-1. Regardless of whether or not displacement is accomplished by echelon, communications must be maintained with the command post of the supported unit throughout the displacement.

b. Since displacement by echelon presents many difficulties, communication plans made before a displacement include the possibility that all means of communication except radio may become temporarily impractical. The primary consideration in a displacement by echelon is that communication must be maintained between the forward and rear echelons of the command post, as well as between the command post and the supported unit, with the forward observers, and the liaison officers. Ordinarily, displacing echelons of a field artillery battalion use the battalion command/fire direction channel.

17. Communication During the Attack

The field artillery commander prescribes the extent to which the wire and radio systems of the units are to be developed in any tactical situation. Initially, communication is by radio and messenger, but wire communication is provided as rapidly as possible. Although speed is essential during the development of the attack, communication security is vital. Since radio traffic is a source of information to the enemy, it is held to a minimum. Messages sent by radio must be brief, and the rules of communication security must be observed. (See ACP 122-series and FM 32-5.) Maximum use is made of authorized codes. (See chapter 20 for typical wire systems and radio nets.)

18. Communication During Reorganization

a. After an attack has reached the objective or has been stopped short of the objective, the force commander may decide to continue the attack, to withdraw, or to defend. In any event, forces are

regrouped and communication systems are reorganized and altered to fit the new plans of action.

b. The reorganization phase is critical for field artillery communication. Field artillery support must be continuous to protect the supported units and to assist in stopping counterattacks. Communication officers maintain existing communication systems and prepare to extend or modify them as soon as a new decision is made. Radio nets continue in operation.

c. In preparation for a displacement, communication officers insure that communications/electronics equipment is salvaged, serviced, and repaired and assist in the redistribution of equipment within the units.

19. Communication During Pursuit

a. The field artillery usually is attached to the unit making the pursuit. The maintenance of communication is more difficult during a pursuit because of the speed of the operation and the increased distances between units. Reliance must be placed on radio communication.

b. Rapid movement requires rapid and frequent displacement. Maintenance of contact between units and between a unit's advance and rear command posts requires message center personnel, messengers, other communication personnel, and appropriate communications/electronics equipment at each installation.

c. When a field artillery unit displaces by echelon, the first echelon includes radio sets for communication in command and fire direction radio nets. Messengers with transportation are maintained as needed at message centers. Aircraft may be used for drop and pickup service.

Section V. COMMUNICATION DURING DEFENSE

20. General

a. In a prepared defense, enough time is available for the planning and installation of a complete wire system. Radio may not be utilized initially, but all nets are established and operators maintain listening watch. Wire communication is provided for liaison officers and forward observers. Duplicate circuits should be established, with different wire routes used if possible. Wire is installed to alternate positions to facilitate early communication if these positions are occupied.

b. Particular attention is given to the maintenance and improvement of wire circuits. Wire

routes that afford maximum natural cover and concealment are selected, regardless of distance. Wire is installed with great care, and improvement of the wire system is continuous.

21. Lateral Communication

Lateral circuits should be established between units to provide coordination and alternate circuits for emergencies. Authority to use commercial or other circuits already in existence is obtained from the division signal officer.

Section VI. COMMUNICATION DURING RETROGRADE MOVEMENTS

22. General

Communication procedures used in retrograde movements generally are similar to those used in forward displacements. The communication officer obtains information regarding routes of withdrawal. He bases the withdrawal communication plan on this information.

23. Planning Communication

The communication officer must be prepared to submit a plan for using existing communication facilities to the best advantage during the withdrawal. On receipt of the necessary information for the plan of withdrawal, he plans the communication system to be used by subordinate units. The plans include—

a. Provisions for strict regulation of radio operation, which may include silencing certain stations or establishing dummy stations, as needed, for deception.

b. A plan for the most effective use of existing wire circuits.

24. Communication During Displacements

a. Communication personnel continue the operation of existing systems while preparing for displacement.

b. If the situation permits, wire not required by units is recovered. When time does not permit complete recovery, the abandoned wire lines should be cut in several places.

c. Radio listening silence normally is maintained during retrograde movements. For the purposes of deception and with approval of higher headquarters, the normal level of radio traffic may be maintained at the old position.

d. All practical means of communication are used, including existing wire circuits between the old and new positions. Messenger service is available at all times.

CHAPTER 3

PRINCIPLES OF RADIO COMMUNICATION

25. Introduction

Radio is a means of communication used for command, fire control, and liaison within and between tactical units. It is particularly adaptable to rapidly changing situations. Communication within highly mobile units would be extremely difficult if radio communication were not available. Radio communication is essential for communication over terrain where it is impossible or impractical to install wire lines. Radio communication is used extensively during the initial stages of combat operations and during fast-moving tactical situations.

26. Radio Waves

Radio signals travel from transmitter to receiver as electromagnetic waves. These waves radiate at the speed of light (300,000 kilometers (km) or 186,000 miles per second). The rapid radiation of these waves provides instant point-to-point communication. The electromagnetic waves are called *radio waves* and are classified according to frequency.

a. Radio frequencies are classified as follows:

(1) Very low frequency (vlf)—below 30 kHz (kilohertz).

(2) Low frequency (lf)—30 to 300 kHz.

(3) Medium frequency (mf)—300 to 3,000 kHz.

(4) High frequency (hf)—3 to 30 MHz (megahertz).

(5) Very high frequency (vhf)—30 to 300 MHz.

(6) Ultrahigh frequency (uhf)—300 to 3,000 MHz.

(7) Super high frequency (shf)—3,000 to 30,000 MHz.

(8) Extremely high frequency (ehf)—over 30,000 MHz.

b. Frequency classification does not extend below 3 kilohertz because considerable power is required for the signal to travel any appreciable

distance at frequencies lower than 3 kilohertz. The majority of stations operate in the bands from the medium through the ultrahigh frequencies; however, a few stations operate on frequencies in the very-low-frequency band for special purposes.

c. The purposes for which these frequencies are used vary, depending on the propagation characteristics of different frequencies. In general, radiation is caused by varying currents traveling back and forth in the antenna. These currents cause an electromagnetic field to build up around the antenna. This field expands outward from the antenna at the speed of 300,000 kilometers (186,000 miles) per second and varies in strength and frequency with the antenna currents. An antenna is an electrical conductor used to radiate radio waves into space or to intercept radio waves in space. The length of the antenna is proportional to the length of the wave radiated. For a specified operating frequency, the length of a transmitting antenna is critical, whereas the length of a receiving antenna usually is not so critical.

d. Polarization of a radiated wave is determined by the direction of the lines of force making up the electric field. If the lines of electric force are at right angles to the surface of the earth, the wave is *vertically* polarized; if the lines are parallel to the earth's surface, the wave is *horizontally* polarized. Normally, a vertical antenna is used for the reception of vertically polarized waves and a horizontal antenna is used for the reception of horizontally polarized waves. When an antenna is used for the radiation of energy, the electric lines of force are built up from one end of the antenna to the other, and, at a distance from the antenna, the lines of force have a direction that is parallel to the direction of the radiating antenna. Therefore, the vertical half-wave or quarter-wave antenna produces a vertically polarized radio wave and the horizontal antenna, a horizontally polarized radio wave.

e. Since the signal radiates 360° around the antenna, logically it will get weaker as it travels away from the antenna. Also, there normally are manmade or natural obstacles that will affect the

transmitting range. A knowledge of these facts will help in understanding the following explanation of the types of wave propagation as they affect military radio transmission.

f. In figure 1 the ground wave is illustrated. Ground wave propagation is dependable under all atmospheric conditions and is used when distance permits. At low frequencies the ground wave extends for a considerable distance, but this distance decreases rapidly as the frequency is increased so that any frequency above the high frequency band has a very short ground wave transmission range.

g. Figure 1 also shows the line-of-sight wave propagation. This method of transmission is available at all frequencies, but in very-high-frequency or ultrahigh-frequency bands it is the only practical means of obtaining reliable communication with low or medium power. If obstructions appear in the line-of-sight path between the transmitting antenna and the receiving antenna, the signal will become weak or be lost. Figure 2 shows how station siting affects communication systems that use the line-of-sight path. Locating a radio behind a

hill or other obstruction will lower the signal strength, but this effect is decreased by moving the radio farther away from the hill.

h. Also shown in figure 1 is the sky wave propagation, which is the type of propagation used for long-range communication. Sky wave propagation over great distances is made possible by the existence of ionized layers in the upper atmosphere. These layers act as a reflector to certain bands of frequencies and cause part of the signal to bend back toward the earth and thereby be made available for reception at points beyond the horizon. Several "skips" may allow the signal to be received at distances of thousands of miles from the transmitter. The ionized layers are continually varying in contour and height so that fading effects are experienced at the distant reception points. Also, the layers rise in daylight and descend at night so that the distance of skips changes from day to night. By use of higher frequencies during daylight and lower frequencies at night, communication with a distant point may be maintained with considerable reliability. Frequen-

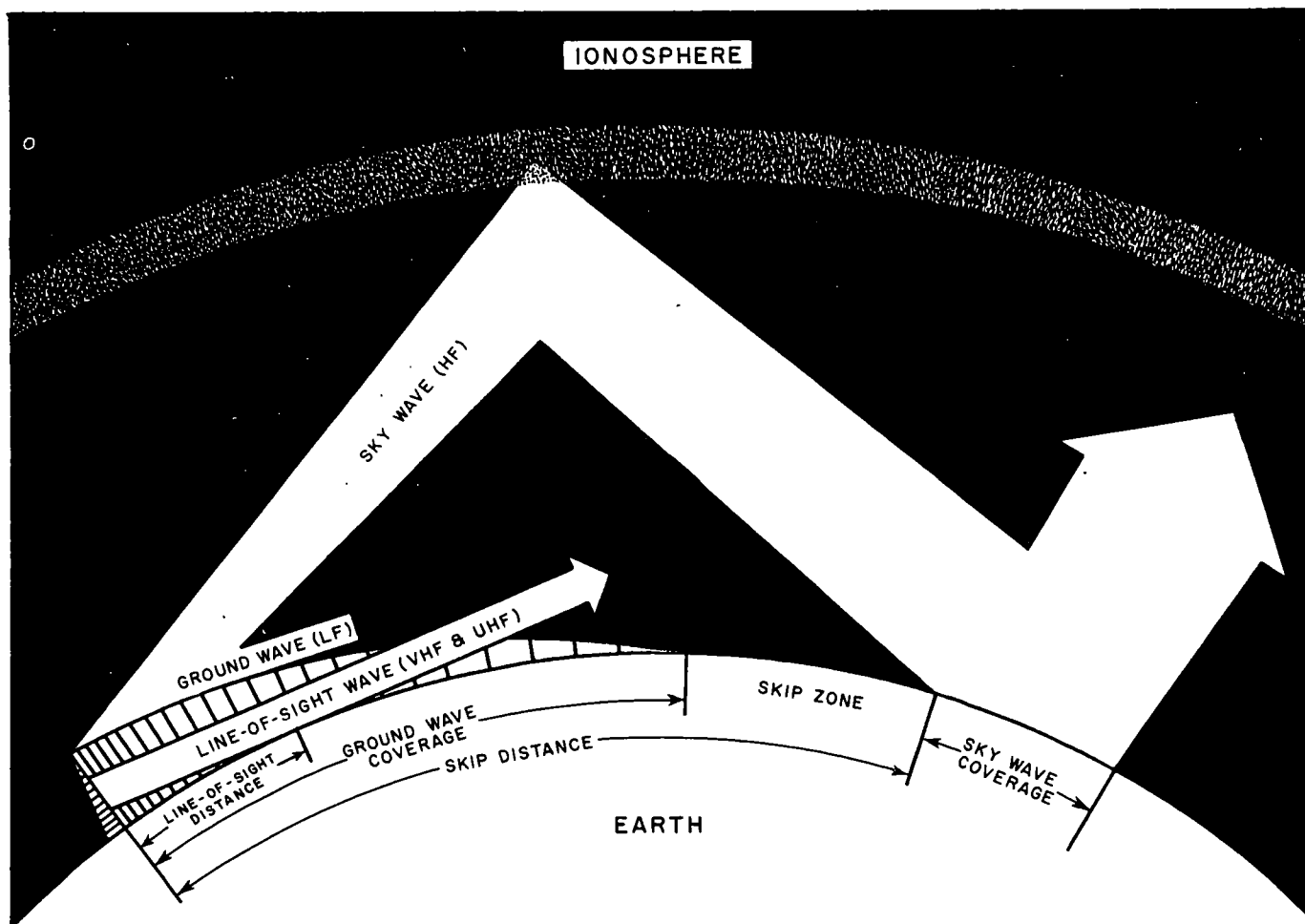
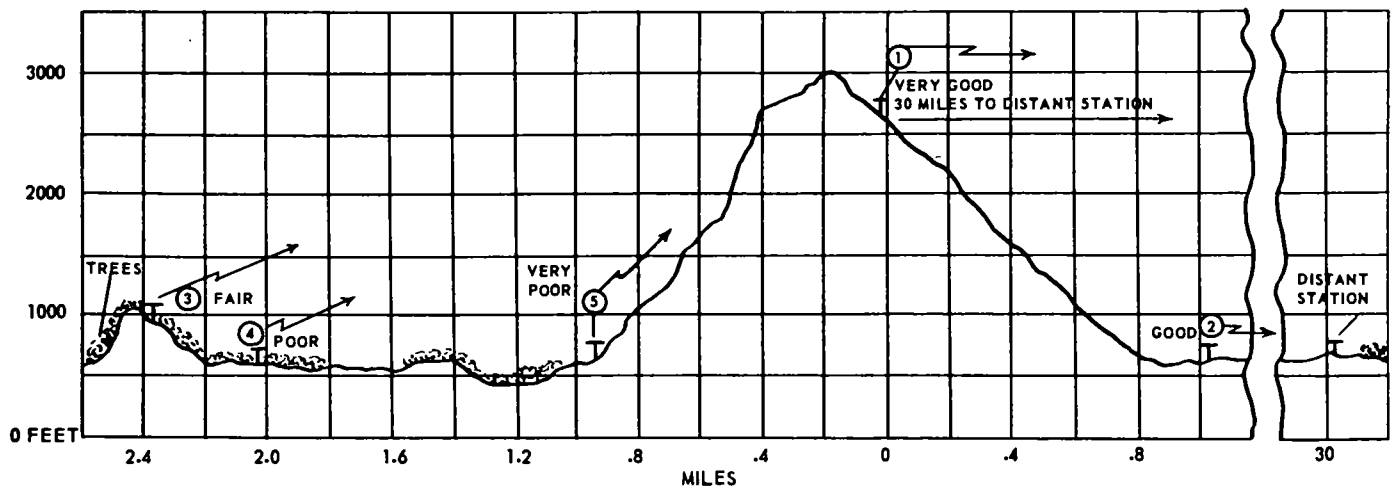


Figure 1. Radio wave propagation.



RELATIVE SIGNAL STRENGTH LOCATION PERCENT RELATIVE TO LOCATION ①	
①	100 (Reference)
②	25
③	10
④	2
⑤	1

Figure 2. Location of antenna in hilly areas.

cies between 4 and 20 megahertz are used for long-distance communication. Frequencies above 20 megahertz are most effective for line-of-sight operation. These frequencies tend to penetrate the ionized layers, thus minimizing the possibility of their use over long distances. No absolute dividing lines can be established for the frequency at which the ground waves become ineffective or at which the sky waves are no longer usable and line-of-sight operation becomes necessary.

27. Radio Frequencies

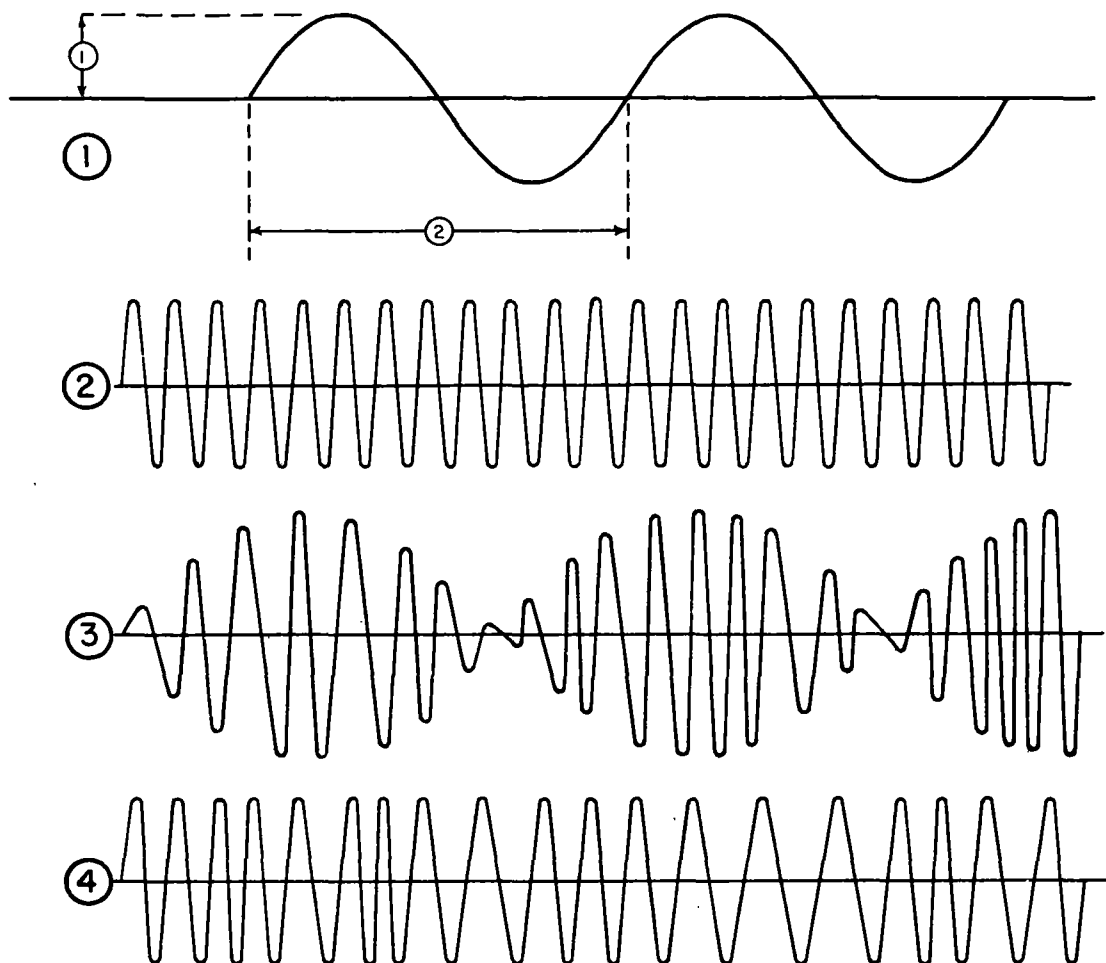
a. Amplitude modulated (AM) radios use the high-frequency band, which is effective in all three types of wave propagation. For short-range transmissions, ground waves are used.

b. Frequency modulated (FM) radios operate in the upper limits of the high-frequency band and the lower limits of the very-high-frequency band and tend toward line-of-sight operation, although ground waves are used for short-distance transmission. Under certain atmospheric conditions, radio waves from FM radio sets take the form of sky waves and can be received at considerable distances. The possibility exists that these reflected waves may be received by distant stations, thus causing interference. The atmospheric conditions

that cause this effect cannot be controlled but, fortunately, seldom occur.

28. The Radio Set

a. Transmitter. The device for sending out radio signals is called a transmitter. The transmitter generates, modulates, and radiates a radio-frequency (RF) signal. A voice transmitter consists of an RF generator (called an oscillator), a power amplifier for increasing the power of the signal to the desired level, a modulator for superimposing the intelligence onto the RF signal, and an antenna for radiating the modulated RF signal. Amplitude modulation is the process of varying the amplitude of a carrier in accordance with the modulating intelligence (fig. 3). Frequency modulation is the process of varying the frequency of an RF carrier wave in accordance with the amplitude and frequency of an audio signal (fig. 3). In both methods, the original RF signal is called a *carrier*, and the frequency of the carrier determines its propagation characteristics. When a carrier is modulated, upper and lower sidebands are formed. Since the transmitter signal consists of the carrier and sidebands, it covers a band of frequencies. The bandwidth for AM transmission is about 10 kilohertz. The bandwidth for FM trans-



- ① AUDIO-FREQUENCY SIGNAL
 - ① Amplitude
 - ② Cycle
- ② UNMODULATED RADIO-FREQUENCY CARRIER WAVE
- ③ AMPLITUDE-MODULATED WAVE
- ④ FREQUENCY-MODULATED WAVE

Figure 3. Comparison of amplitude and frequency modulation.

mission is determined by the amount of frequency change with modulation. The differences in bandwidths of AM and FM bands indicate that many more AM stations than FM stations can be operated on a given band of frequencies.

b. Receiver. The radio receiver uses the electromagnetic waves in the air to develop an electrical signal, which is then amplified and demodulated. Radio waves passing an antenna generate minute electrical currents in the antenna that correspond in both frequency and amplitude variation to the radio waves that generated them. These minute currents enter the receiver. A series of amplifiers, each with selective circuits, picks out the

band of frequencies corresponding to the signal from a desired station and amplifies the signal until it becomes fairly strong. This signal still contains the variations corresponding to the intelligence, either in the form of frequency or amplitude modulation. A demodulator is used to remove the intelligence from the carrier. In FM operation the demodulator is called a *discriminator*, and in AM operation the demodulator is called a *detector*. In either case the result is the discarding of the RF carrier and the developing of a signal in the audio frequency range. The intelligence is then further amplified and made to operate a loudspeaker, an earphone, or other device, thus converting electromagnetic waves into audible sound waves.

CHAPTER 4

DUTIES OF COMMUNICATION PERSONNEL

29. General

The tables of organization and equipment (TOE), from the highest echelon of field artillery to battery level, authorize communication personnel whose primary duties are to install, operate, and maintain communication systems. Field artillery units of battalion size and larger are authorized a communication officer who is a signal corps officer as a member of the commander's special staff.

30. Communication Platoons

Each artillery battalion and higher headquarters is authorized a communication platoon which normally is organized as shown in figure 4.

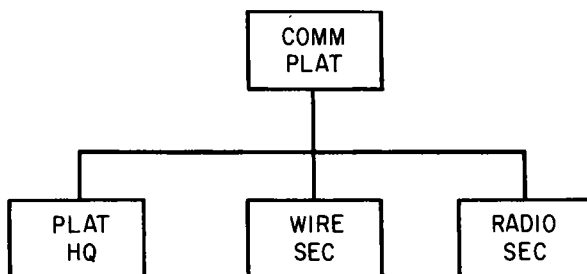


Figure 4. Organization of communication platoon.

a. *Platoon Headquarters.* The communication platoon headquarters generally consists of the assistant communication officer, who is also a signal corps officer and who commands the platoon; the communication chief; radio mechanics; and the message center personnel. In units that are not authorized an assistant communication officer, the communication chief is in charge of the platoon.

b. *Wire Section.* The wire section includes a section chief, wire teams, and switchboard operators, the number depending on the type of unit.

c. *Radio Section.* The radio section includes a section chief and sufficient radio operators and radio teletypewriter operators to operate the equipment organic to the section.

31. Communication Personnel in Other Sections

In some units, radio and radio teletypewriter operators are assigned to sections other than the communication platoon. Although each operator functions in the section to which he is assigned, the radio section chief should supervise his training and performance.

32. Battery Communication Sections

The battery communication section generally consists of a communication chief, wire teams, and switchboard operators, the number depending on the type of unit.

33. Duties of Communication Officer

a. The communication officer is a signal corps officer. He is a member of the commander's special staff. Although staff officers may prepare and transmit orders to subordinate units, they do so only as representatives of, and in the name of, the commander. The scope of this authority is determined by the commander's policy.

b. As a representative of the commander, the communication officer has the following responsibilities.

(1) *Reconnaissance.* Recommends the general location of the command post, as viewed from the communications standpoint in coordination with the S3 and headquarters battery commander.

(2) *Plans.* Plans the communication system of the unit with attached, reinforced, and supported units; coordinates displacement communications plans.

(3) *Direction and supervision.* Directs and supervises the installation, operation, and maintenance of the communication system of the unit.

(4) *Adviser to commander and staff.* Advises the commander and staff of pertinent electrical countermeasures and antijamming techniques.

(5) *Administration.*

(a) Prepares communication SOP and communication portions of orders.

(b) Submits report, line route maps, etc., to higher headquarters.

(c) Advises the S4 on supply matters pertaining to communications/electronics equipment.

(6) *Liaison*. Contacts communication officers of senior, subordinate, reinforcing, reinforced, and adjacent units to coordinate and to improve communications.

(7) *Training*. Plans and supervises all communication training in the unit.

(8) *Inspections*. Conducts technical inspections of communications/electronics equipment.

34. Duties of Assistant Communication Officer (Communication Platoon Leader)

The assistant communication officer assists the communication officer in all his functions and has the following additional duties.

a. Direction and Supervision. Exercises direct supervision over the installation, operation, and maintenance of all communication equipment installed by headquarters battery. Supervises the maintenance of equipment in headquarters battery. Commands the communication platoon.

b. Administration. As executive officer of headquarters battery, assists headquarters battery commander in battery administration.

c. Training. Conducts the training of the communication platoon.

35. Relationship Between Headquarters Battery Commander, Communication Officer and Assistant Communication Officer

a. The assistant communication officer, if he is also executive officer of headquarters battery, is the assistant to the headquarters battery commander, that is, he is second in command.

b. The headquarters battery commander and the communication officers must cooperate on such matters as—

- (1) Assignment and promotion of communication personnel.
- (2) Training of communication personnel.
- (3) Supply and maintenance of equipment.
- (4) Selection of installations within the command post area.
- (5) Use of communication personnel.

36. Duties of Communication Chief

The communication chief—

a. Takes personal charge of the installation of all communication means established by his unit and supervises their operation and maintenance.

b. Assists in the conduct of instruction and in the training of the communication platoon or section.

c. Keeps himself informed of all communication aspects of artillery operations.

d. When appropriate, performs the duties of the assistant communication officer.

e. Coordinates all communication within the command post.

f. Supervises message center operations.

g. Supervises and coordinates, under the direction of the communication officer, organizational maintenance of communications/electronics equipment within the battalion.

37. Duties of Chief Message Clerk, Senior Message Clerk (Battalion and Higher Headquarters), and Message Clerk (Code Clerk)

The chief message clerk, senior message clerk, and message clerk—

a. Installs and operates the message center.

b. Keeps message center records.

c. Trains and supervises message clerks and messengers.

d. Processes messages delivered to the message center.

e. Encodes and decodes messages.

f. Enciphers and deciphers messages.

38. Duties of the Field Radio Mechanic (MOS 31B20) and the FADAC/Field Radio Mechanic (MOS 31B30)

a. Any Field Radio Mechanic 31B20 who receives an additional two weeks training on FADAC maintenance, qualifies for MOS 31B30. (See AR 611-201.) Cannon battalions and Honest John battalions require a 31B30 if they are equipped with FADAC. All other missile battalions and field artillery units not authorized FADAC require 31B20. The field radio mechanic 31B20 performs the following duties—

(1) Organizational maintenance on tactical communication, COMSEC and RADIAC equipment.

(2) Schedules and performs preventive maintenance.

(3) Prepares and maintains equipment records.

b. The FADAC/Field radio mechanic 31B30 performs the duties outlined in *a* above, and in addition he will perform organizational maintenance.

nance on the M-18 Gun Data Computer (FADAC) and all associated test equipment.

39. Duties of Wire Section Chief

The wire section chief—

- a. Reconnoiters wire routes.
- b. Plans wire systems.
- c. Takes personal charge of the installation, operation, and maintenance of all wire installed by headquarters battery.
- d. Trains wire section personnel.
- e. Serves as communication chief during the latter's absence.

40. Duties of Wire Team Chief

The wire team chief—

- a. Selects wire routes.
- b. Assists in the preparation of line route maps.
- c. Installs and maintains wire lines.
- d. Trains wiremen and telephone and switchboard operators.
- e. Serves as wire section chief during the latter's absence.

41. Duties of Radio Section Chief

The radio section chief—

- a. Selects locations for the elements of the radio and panel stations.
- b. Organizes the radio system at the command post.
- c. Trains members of the radio section.
- d. Reports any changes in radio communications status to the message center.
- e. Assists the communication chief in supervising organizational maintenance of radio equipment within the unit.

42. Communication Teams

- a. All communication personnel must be able to perform the duties of other members of the section, i.e., operate switchboard and radiotelephone equipment, use the SOI and SSI, operate motor vehicles, and act as messengers.
- b. All personnel discussed in paragraphs 33 through 41 function as members of teams. They must be trained in the basic military subjects of sanitation, field fortifications, camouflage, local security, maintenance of equipment, etc. The communication teams and their general capabilities are listed below.

(1) Message center team.

- (a) Clears messages through the message center without delay.
- (b) Plans and executes synchronization of time.
- (c) Maintains a record of signal operation instructions, and changes thereto and distributes the changes promptly to the interested agencies.
- (d) Knows the status of communication at all times in order to utilize available means most efficiently.
- (e) Encrypts and decrypts messages.
- (f) Safeguards cryptographic systems and equipment.

(2) Wire section team.

- (a) Prepares the unit wire SOP in conjunction with the assistant communication officer.
- (b) Establishes wire communication with minimum delay, using proper procedures, and coordinates the activities of wire personnel of subordinate units.
- (c) Cooperates with wire personnel of senior, subordinate, adjacent, reinforced, and supported units to maintain continuous communication.
- (d) Maintains uninterrupted wire communication during displacements, when applicable.
- (e) Works closely with the unit message center.
- (f) Observes rules of transmission security.
- (g) Negotiates difficult terrain, using simple pioneer methods.
- (h) Notifies the message center of any change in status of wire communication.

(3) Radio section team.

- (a) Prepares the unit radio SOP in conjunction with the assistant communication officer.
- (b) Establishes radio stations promptly when the time and place for opening nets are indicated.
- (c) Coordinates the activities of radio personnel of subordinate units.
- (d) Enforces net discipline and transmission security.
- (e) Assumes the entire traffic load of the unit at any time.
- (f) Functions as a panel team.
- (g) Works closely with the unit message center.
- (h) Notifies the message center of any change in status of radio communication.

CHAPTER 5

MEANS AND PRINCIPLES OF COMMUNICATION

Section I. MEANS OF COMMUNICATION

43. General

Within field artillery units, the means of communication available are radio/wire, visual, and sound, which are classified as telecommunications and messenger which is a physical communications means. The composition of the means in each unit depends on the personnel, equipment, and transportation provided by its table of organization and equipment and by the unit or higher commander. The various means of communication have different capabilities and limitations; consequently, they are so employed that they complement each other and that total dependence is not placed upon any one means. The reliability of communication systems is greatly increased by the use of all the means available. However, the failure of one or all available electronic means does not relieve a commander of his communication responsibility. In brief, the means employed in a given situation generally are those that provide the maximum reliability, flexibility, security, and speed.

44. Wire Communication

a. General. Wire is one of the field artillery's principal means of communication and includes the use of field telephone wire, cable assemblies, wire laying and recovery equipment, battery-operated and sound-powered telephones, switchboards, teletypewriters, and associated equipment. It affords person-to-person conversation with break-in operation (capability of interrupting the conversation). Wire generally affords more security than radio communication, but the security of classified information is never assured when transmitted in the clear. The decision to establish wire communication depends on the need for it, the time available to install and use it, and the capability to install and maintain it. The supply of wire on hand, the expected resupply, and future needs are also considered. Wire communication can be used over most terrain and in most situations. Tables of organization and equipment provide units with

equipment to install and maintain their wire communication systems. For the employment of wire communication in various units, see chapter 20.

b. Range. When battery operated telephones are used, the planning range of field wire circuits is from 22 to 35 kilometers (14 to 22 miles). When sound-powered telephones are used, the planning range is 6 to 16 kilometers (4 to 10 miles). In short, the range of wire communication varies, depending principally on the weather and the condition of the wire. Wet weather, poor splices, and damaged insulation reduce the range appreciably.

c. Time Required for Installation. More time is required to install wire communication than to install any other means. The time required depends mainly on the length of the lines and the method of laying (vehicle, aircraft, or manpack). Other factors to be considered in estimating the installation time are the personnel available and their training, the terrain, routes, weather, and visibility.

d. Installation.

(1) Wire lines usually are laid by wire teams. One man on foot can lay a short wire line by using a wire dispenser or light reeling equipment. Across bodies of water or unusually difficult terrain, wire may be laid from dispensers attached to light aircraft or attached to a rocket and fired over an obstacle. For details on laying wire from a dispenser, see TM 11-2240.

(2) A wire line generally is laid on the ground parallel to a road with 15- to 20-percent slack. Lines may be strung overhead in areas such as command posts, where it is impracticable to bury the lines or leave them lying on the ground. When wire is laid across roads, it is buried, strung overhead, or placed under bridges and through culverts. Areas in which wire is likely to be damaged by traffic or enemy fire are avoided. Part of a wire team lays the wire, and the remainder of the team polices it (throws it off the road, makes road

crossings, etc.). The laying of a line is not delayed for policing however, except at critical points.

e. Switchboards. Switchboards are used to increase the flexibility of the wire systems and to reduce the number of wire lines needed. The line capacities of switchboards vary.

f. Use of Telephones. Telephones are reserved for occasions when there is a need for discussion and speed. To insure that calls are brief and to facilitate the entry of messages in the unit or staff journal, telephone users should reduce the essential parts of messages to writing before conversations begin. During critical periods the use of telephones may be restricted to designated personnel, except for emergency calls.

g. Use of Teletypewriters. In some artillery units teletypewriters are used in wire or radio circuits to transmit messages. This equipment furnishes both parties a written record of the messages exchanged in the form of a printed page or perforated tape or both.

45. Radio Communication

a. General. Since radio is a principal means of communication, a sufficient number of radios are provided to make radio communication available to all commanders and key staff officers. Additional radios are provided for command posts, for fire control, and for other uses. All radio sets issued within the field artillery are capable of voice operation. Radios are also provided for communication between aircraft and from air to ground. The types of radio equipment organic to artillery units are discussed in chapter 14. For the employment of radio communication in various units, see chapter 20.

b. Capabilities and Limitations. Radio communication is subject to natural interference (static), interference from other radio stations and deliberate interference (jamming) by unfriendly forces. Its reliability depends largely on the skill of the operators. The tactical situation and the characteristics of the radio sets dictate their employment. The most important characteristics of the radio sets used in field artillery units are shown in chapter 14. To be capable of operating together, radio sets must have a common or overlapping frequency range, be of the same type of modulation, and transmit and receive the same type of signal. In addition the stronger set must be kept within the transmitting range of the weaker set. The operating ranges shown in chapter 14 are for average conditions; the ranges obtained may be more or less, depending on the

skills of the operators, the weather, the terrain, the interference, and the locations from which the sets are operated. Powerlines and steel structures close to operating sites reduce operating ranges.

46. Messenger Communication

a. General.

(1) Messenger communication is a supplementary means available to all units. The efficiency of messenger service depends on the selection and training of the individuals who serve in this capacity.

(2) Messenger communication is the most secure of all the means of transmission and it is flexible and reliable. Its speed depends on the mode of travel, which may be by foot, motor vehicle, or aircraft. It is the only means available for transmitting large size maps and documents. Messenger service has some limitations, however. It is vulnerable to enemy action in forward areas, does not afford person-to-person conversation, and requires more time.

(3) Messengers are used when security dictates or when messenger service is faster than other means. Messenger service is an effective means for delivering long messages over short distances.

b. Types of Messenger Communications. Messengers, either scheduled or special, are grouped according to their mode of transportation (e.g., scheduled motor messenger, special air messenger, scheduled foot messenger, etc.). Scheduled messengers are used when unit locations change infrequently and the quantity of traffic warrants a routing schedule. Special messengers are used whenever more rapid service or special handling is required.

c. Messenger Employment. Messengers are briefed on the route, rate of travel, location of delivery points, and whether an answer is expected. Very important messages may be sent over more than one route and/or by two messengers. Two messengers normally are used when extremely hazardous combat conditions make single-messenger delivery questionable. They should keep in sight of each other, but far enough apart to prevent simultaneous injury, death, or capture. Advance reconnaissance of proposed messenger routes should be made, where practicable, to determine usability during day and night. Messenger relay posts may be established when there is frequent message service between the same points or units. Other factors to be considered in estab-

lishing messenger relay posts are distance, difficulty of the terrain, and hostile activity.

47. Visual Communication

a. General. Visual communication is a supplementary means of communication that is available to all units. Visual signals in field artillery units are generally limited to panels, arm-and-hand signals, and other prearranged visual signals, such as pyrotechnics and the maneuver of aircraft. These visual means are suitable for transmitting prearranged messages rapidly over short distances. However, these visual signals are easily misunderstood. They are vulnerable to interception and the enemy may use similar signals to deceive or to create confusion. Their use is restricted during periods of poor visibility or when line-of-sight locations are not available; in addition, they may be prohibited for security reasons.

b. Panels. Two general types of panels are issued for communication with aircraft—marking and identifying panels and panels for transmitting messages. Marking and identifying panels are made in bright fluorescent colors. They may be used to mark positions and identify units as friendly. Black and white sets of panels for transmitting messages are issued for use on light and dark backgrounds, respectively. They are used to transmit brief messages or to identify a particular unit. The combined panel system and panel recog-

nition code, which is included in the unit SOI and FM 21-60, is used for this type of visual communication.

48. Sound Communication

Sound communication is also a supplementary means of communication that is available to all units. Sound signals are transmitted by whistles, bugles, horns, gongs, klaxons, weapons, and other noisemaking devices. They are used chiefly to attract attention, transmit prearranged messages, and spread alarms; they are kept simple to prevent misunderstanding. They serve as a rapid means of communication over short distances. On the other hand, sound signals are very vulnerable to interception, and their use may be prohibited for security reasons. Their range and reliability are greatly reduced by battle noise.

49. Integration of Radio and Wire Communication Systems

Wire and radio are separate and distinct means of communication. They may be closely integrated in operation by using radio/wire integration equipment and radio relay equipment. For details pertaining to remote control equipment and the interconnection of radio and wire systems, see the 11-486 series of technical manuals. For procedure to be used with radio/wire integration, see chapter 11.

Section II. PRINCIPLES OF COMMUNICATION, ESTABLISHMENT AND RESPONSIBILITY

50. General

Responsibility for the establishment of communication at various echelons of command is specified in paragraphs 51 through 55. Variations may occur, depending on the tactical mission of the unit. Although one unit may be specifically charged with establishing and maintaining communication with another, both units coordinate the initial establishment of communication; the commanders of both units are equally responsible for taking immediate and aggressive action to restore disrupted communication. A commander is personally responsible for the adequacy and proper utilization of the communication system within his command and for its efficient operation in the system of the next higher headquarters. The authority to establish, maintain, control, and coordinate the employment of the various communication means within a command may be exercised by a subordinate in the name of the commander. However, the command responsibility for these

means cannot be delegated. The basic principles of command responsibility are discussed in detail in FM 22-100.

51. Senior to Subordinate

The commander of a higher echelon or senior unit is responsible for the establishment and maintenance of communications to a unit of a lower echelon or to a subordinate unit. Attached units are subordinate to the command to which attached.

52. Supporting to Supported

The commander of a supporting unit is responsible for the establishment and maintenance of communications to the supported unit.

53. Reinforcing to Reinforced

The commander of a unit reinforcing the fires of another artillery unit is responsible for the estab-

lishment and maintenance of communications to the reinforced unit.

54. Lateral Communication

Responsibility for the establishment of lateral communication between adjacent units may be fixed by the next higher commander or may be established in the standing operating procedure (SOP). In the absence of specific orders fixing the responsibility, the commander of the unit on the left is responsible for establishing communication with the unit on the right.

55. Internal Communications

The commanding officer of each unit is responsible for the installation, maintenance, and operation of the internal communications of his command.

56. Maintenance

Effective maintenance requires the close coordination and joint participation of all units concerned.

If communication is disrupted, its reestablishment is the joint duty of all units affected, although the responsibility remains with the unit that is responsible for installing the line.

57. Practical Application of Principles of Communication

a. The principles set forth in paragraphs 51 through 55 clearly define the responsibility for establishing and maintaining communications. Such responsibility cannot be delegated but can be transferred from one commander to another when so ordered by a higher commander.

b. The installation of communications is not necessarily accomplished by the unit of the responsible commander. It often becomes necessary for the responsible commander to delegate the actual installation of communications to subordinate units. Such practice is not a deviation from established principles, since only the physical installation is delegated, not the command responsibility.

CHAPTER 6

COMMUNICATION SECURITY

Section I. GENERAL DISCUSSION

58. Definition

Communication security is the protection resulting from all measures designed to deny unauthorized persons information of value which might be derived from a study of our communications. Communication security includes transmission security, cryptographic security, and physical security.

59. Responsibility

a. Communication security is a command responsibility. However, every individual engaged in the preparation of material for transmission or in the actual transmission of material is responsible for compliance with procedures governing preparation, transmission, and safeguarding of communications.

b. In carrying out his communication security responsibilities, the commander normally is assisted by the intelligence officer, who plans, coordinates, and exercises staff supervision over security matters within the command, and by the communication officer. To fulfill his responsibility for communication security, the commander must—

(1) Maintain a continuous control system to account for classified information, equipment, and material.

(2) Conduct periodic and thorough inspections to determine the adequacy of physical security measures for the protection of classified information and cryptographic equipment and material and to insure that cryptosystems are properly used.

(3) Develop adequate emergency plans, including emergency destruction plans.

(4) Consider communication security requirements in all operation planning.

(5) Take remedial action to eliminate causes of communication security violations.

c. Responsibility rests with each person of the command to assist the commander in fulfilling his task. The security consciousness of the individual is an important factor, since communication systems cannot overcome the effect of carelessness. Discussion of classified information with unauthorized personnel or in inappropriate places constitutes a great hazard to security. Therefore, it is the responsibility of the individual to report any apparent violation of, or weakness in, communication security to his superior.

60. Security Classification

Security classification is based on the degree of danger to national security which would result from unauthorized disclosure of military or official information. The classification system establishes a standard of care for handling, storage, and dissemination of information belonging to each classification. Security classifications are discussed in detail in AR 380-5.

61. Security Measures

Security measures for the protection of military information, equipment, and material include defense against capture, salvage, theft, espionage, observation, photography, interception, direction finding, traffic analysis, cryptanalysis, and imitative deception. High standards in training will reduce carelessness and laxity of personnel. It is of utmost importance that all personnel remain alert at all times to provide adequate protection of defense information, equipment, and material.

Section II. CRYPTOGRAPHIC SECURITY

62. Definition

Cryptographic security is that part of communication security which deals with the proper use of authorized codes, cipher devices, and machines for encrypting and decrypting messages. For detailed information on the handling of cryptographic material, see AR 380-40, AR 380-41, and AR 380-46. The following cryptographic systems are available to most field artillery units:

a. Operations Codes. Operations codes may be used for general or limited purpose communications but may not be used when a more secure system is available. Operations codes may not be used in conjunction with any other security code. For further details, see appendix I of AR 380-52.

b. Numeral Codes. Numeral codes are used to encrypt map references, and other numerical information which must be encrypted when, for operational necessity, the remainder of the message is transmitted in plain language. For further details, see AR 380-52.

c. Cipher Machines and Devices. On-line and off-line cipher equipment will be available to most units requiring such equipment. Additionally, speech security equipment is available in certain artillery units.

63. Sending Messages in Clear Text

a. Army regulations require that all classified messages be transmitted in cryptographic form unless, during actual hostilities, the urgency of a message does not permit encrypting and the enemy will not have sufficient time to act upon the information contained in the message. The exception to this rule concerns messages classified TOP SECRET; they are *never* transmitted in the clear over electrical means. The transmission of a classified message in the clear must be authorized by the commander of the headquarters transmitting the message or his specifically designated representative. For further details, see AR 380-51.

b. In an effort to conceal the contents of unclassified messages transmitted by electrical means, the messages should be encrypted for transmission. When this technique is used, the abbreviation "EFTO" (encrypted for transmission only) will be used in place of the security classification in the message format. See AR 380-26 for information on proper use of this technique and when to use it.

64. Compromise, Loss, or Possible Compromise

a. An essential part of cryptosecurity is the prompt reporting of possible or actual compromise of cryptomatter. Prompt action is necessary so that cryptomaterial determined to have been compromised may be withdrawn from further use and information encrypted with the compromised systems may be reviewed and necessary action taken. The report should contain as much of the following information as is applicable:

- (1) Nature of violation.
- (2) Identity (publication, system, or equipment).
- (3) Length of message(s).
- (4) Date-time group.
- (5) Means of transmission.
- (6) Originator and addressee.

b. In the event of loss or physical compromise subsequent to the initial report, a thorough investigation will be made and a complete report will be sent through appropriate channels to the Army Security Agency. For further details see AR 380-40.

65. Clearance of Personnel

a. No person is entitled to knowledge or possession of classified material solely by virtue of his grade. Such material will be entrusted only to those individuals whose official or government duties require such knowledge. All persons whose duties require access to classified material must be cleared to receive classified information.

b. Formal authorization for access to cryptoinformation is required. Subject to local regulations, commanders may grant such access in accordance with AR 604-5. Before granting such access the commander must review the individual's 201 file or official personnel folder, as appropriate, to verify that the following forms have been executed:

- (1) DA Form 873 (Certificate of Clearance and/or Security Determination).
- (2) DD Form 98 (Armed Forces Security Questionnaire) or DA Form 111 (Certificate of Nonaffiliation with Certain Organizations), as appropriate.
- (3) DA Form 2545 (Cryptographic Access Authorization, Briefing Certificates).

Section III. PHYSICAL SECURITY

66. Definition

Physical security is that portion of communication security pertaining to the physical measures necessary to safeguard classified communication equipment and material from access by unauthorized persons. For details on safeguarding, distributing, and accounting for cryptomaterial, see AR 380-40, and AR 380-41.

67. Need for Physical Security

Unsuspected physical compromise is far more serious than known loss. If an undisclosed compromise occurs and the cryptosystem continues in use, an enemy may be able to decrypt all traffic sent in that system.

68. Procedures for Physical Security

Effective physical security insures the maximum

protection of classified material from production to destruction. Protection against physical compromise of classified communication equipment and material can be accomplished by observing the following precautions:

- a. Proper handling by all personnel concerned.
- b. Adequate storage when not being used.
- c. Complete destruction when required.

69. Destruction of Classified Material

Certain nonregistered classified material is destroyed when directed by competent authority. All such material will be destroyed by burning, if possible. As far as is humanly possible, classified material will not be permitted to fall into enemy hands. Destruction should be carried out as described in AR 380-5, and AR 380-40.

Section IV. TRANSMISSION SECURITY

70. Definition

Transmission security includes all measures designed to protect transmissions from interception, traffic analysis, imitative deception, and direction finding.

71. Means of Transmission

Users of communication systems should select the means most appropriate to the delivery of messages in accordance with the specified precedence and security requirements. Means and types of transmission available are—

- a. Messenger.
- b. Mail.
- c. Approved wire circuits.
- d. Nonapproved wire circuits.
- e. Visual.
- f. Sound.
- g. Radio.

Note. For more information concerning the means of transmission listed in *a* through *g* above, see FM 32-5 and ACP-122 ().

72. Message Preparation

a. Transmission security within a command can be greatly enhanced when personnel directly concerned with message preparation are familiar

with the fundamentals of transmission security. Such personnel include the—

(1) *Originator*—The commander by whose authority messages are sent. The responsibility of the originator includes the functions of the drafter and the releaser.

(2) *Drafter*—The person who prepares a message.

b. Although all messages are sent in the name of the commander, few are likely to be written by him personally. It is, therefore, of utmost importance that a commander insure that the message writers within his command know the principles of communication security. For details pertaining to message preparation, see chapter 8. In fulfilling his responsibilities, the drafter must consider the following:

(1) *Classification*—The originator is responsible for the proper security classification of a message.

(2) *Text*—The text of a message must be clear, accurate, and as brief as possible.

(3) *Precedence*—Each message should be assigned the proper precedence, depending on the importance of the message and the requirements for rapid delivery. Improper precedence can cause overloaded communication facilities. For further details, see AR 105-31 and FM 24-17.

73. Communications Intelligence

Communications intelligence (COMINT) consists of all measures taken by the enemy to obtain intelligence from our radio communication. *Strict radio silence is the primary defense against radio intelligence.* Interception and direction finding can be made more difficult by—

- a. Avoiding unauthorized transmissions and unnecessary testing, thus decreasing the opportunities for direction finding.
- b. Using a combination of transmitters, antennas, and power to produce minimum wave propagation and emission intensity consistent with reliable communications.
- c. Using the broadcast method of transmitting traffic whenever possible in preference to the receipt method.
- d. In the absence of a prearranged plan, concealing the instructions to shift frequency by encryption.
- e. Adjusting the transmitter accurately, adhering to the authorized frequency, and maintaining strict circuit discipline.

74. Operator Training

Operating and maintenance personnel must be trained to recognize and avoid the following practices which endanger communication security:

- a. Violation of radio silence.
- b. Unofficial conversation between operators.
- c. Transmitting in a directed net without permission.
- d. Excessive repetitions of prosigns or operating signals.
- e. Use of plain language in place of applicable prosigns or operating signals.
- f. Use of unauthorized prosigns.
- g. Incorrect and unauthorized procedure.
- h. Identification of unit locations.
- i. Failure to maintain radio watches on designated frequencies and at prescribed times.
- j. Identification of individuals belonging to an organization.
- k. Transmitting at speeds beyond the capabilities of receiving operators.
- l. Use of excessive transmitting power.
- m. Consuming excessive time in tuning, testing, changing frequency, or adjusting equipment.
- n. Improper use of call signs.

75. Jamming

Enemy jamming is the transmission of disturbing radio signals to interfere with the reception of the desired signal. The effects sought by the enemy are to disrupt our system and deny its use to our forces. Techniques employed to minimize the effects of jamming are called antijamming. The term "electronic counter-countermeasures" (ECCM) includes antijamming. See chapter 16 for more details on jamming.

- a. All radio frequencies are vulnerable to jamming, and the enemy will jam radio transmissions whenever it is advantageous. To accomplish this, he will select the frequency to be jammed, tune a transmitter to that frequency, and transmit a strong signal to block reception of the desired signal.
- b. There are two sources of interfering signals, external and internal. If the disturbance heard in the receiver can be eliminated or substantially reduced by grounding or disconnecting the receiving antenna, it may be assumed that the trouble is being caused by some external source. If the disturbance remains unchanged when the antenna is disconnected or grounded, the set is not functioning properly. If interference is caused by some external source, a further check must be made to determine whether the cause is enemy jamming or accidental interference.
- c. In most instances, antijamming measures will be beyond the efforts of operators. The enemy can jam all radio circuits. Therefore, until jam-proof equipment and techniques are developed, all possible steps must be taken to minimize the effects of enemy jamming. It is imperative that the radio operator continue to operate his set during enemy jamming attacks. The skill of the radio operator determines his ability to work effectively through jamming. He should remain calm and persist in applying the proper antijamming techniques and procedures. Most current radio relay equipment has been designed with built-in antijamming features.
- d. A prompt, accurate, and complete report of enemy jamming is important, since an enemy jamming attack is usually part of a well organized plan and frequently precedes important tactical maneuvers. The reports from the individual radio operators, which frequently provide intelligence on the extent and importance of enemy action, normally are compiled at division or corps headquarters by electronic warfare personnel. Prop-

erly correlated jamming information may serve as a warning of impending enemy action in a sector or on a broad front.

76. Telephone Security

It is most important for users of the telephone to understand the relative security inherent in different types of circuits. Even if the circuits are cleared for transmission of classified material, they must still be used with extreme care. Just as the chain is as strong as its weakest link, the weakest part in the overall telephone circuit determines the security of the circuit. When a telephone connection contains weak links (such as a simple two-wire telephone circuit near the front, a simple two-wire circuit among unfriendly inhabitants, or a radio link circuit in a telephone system

employed under similar conditions), there is no communication security even though the major part of the overall circuit is secure. For this reason, a high degree of telephone discipline must be observed by telephone users in a system.

77. Monitoring

Radio monitor stations set up by central control agencies under area or higher commands are a vital factor in attaining the most effective overall circuit discipline and operator efficiency. Violations of transmission and cryptosecurity and deviations from prescribed procedures may be discovered by monitoring. Such violations and deviating should be reported to the responsible commanders, together with suitable references, instruction material, and log excerpts.

Section V. AUTHENTICATION

78. General

Authentication is a communication security measure which protects against imitative communication deception. The authentication system used within a command will be specified and procured by the commander concerned. Commanders at all levels are responsible for expressing their requirements for the authentication system necessary for maintaining communication security within their respective commands. Requests for authentication systems should be submitted through command channels to the Commanding General, U.S. Army Security Agency (CGU-SASA) in accordance with instructions contained in AR 380-52.

79. Procedures

Procedures for use of each authentication system will be provided with the system when issued.

80. Transmission Authentication

By use of transmission authentication, a calling station can establish its validity without requiring any transmission from the called station. The test elements used by the calling station are selected by prearrangement according to the specific authentication system in effect. See AR 380-52.

81. Challenge and Reply Authentication

Upon receipt of a challenge, the challenged station uses the challenge to obtain an authenticator in accordance with the operating procedure for the individual authentication system. The challenger must also determine the authenticator to ascertain that the reply as received is correct.

Note. On receipt of a challenge, the challenged station should not request a standby unless it is essential for operational reasons. If a standby is requested, the challenger should send a second challenge with different test elements when communication is resumed.

CHAPTER 7

SIGNAL ORDERS AND INSTRUCTIONS

82. The Operation Order

a. General. The operation order is a means by which a commander directs his organization in an operation. In some cases, because of a time limitation, it may be impossible to prepare complete written signal estimates and plans. Therefore, it sometimes becomes necessary that paragraph 5 (the signal portion) of the operation order be prepared on the basis of the communication officer's estimate and plan. The signal portion may be issued orally. The signal portion of the operation order must be issued in sufficient time to permit the installation of the required communication systems before the beginning of the action concerned. For details on paragraphs 1, 2 and 3 of the operation order, see FM 101-5.

b. Paragraph 4, Administration and Logistics. Details of communications/electronics supply and repair may be included in paragraph 4 of the operations orders as follows:

- (1) Special priority of signal troops or vehicles on roads.
- (2) Locations of communications/electronics depots.
- (3) Communications/electronics distribution points.
- (4) Special instructions concerning the issue of communications/electronics supplies.

c. Paragraph 5, Command and Signal. The extent of the communication instructions and information contained in paragraph 5 of the operation order depends on the decision of the unit commander. Paragraph 5 may contain the index number and issue number of the signal operation instructions (SOI) which are in effect, or it may be expanded to include reference to the signal annex (if one is included) or to repeat important instructions of the signal annex or SOI. It may also contain other information of importance that is deemed necessary or desirable by the commander; e.g., locations of subordinate command posts, axis of signal communication, locations of advance message centers, restrictions

on the use of equipment and pyrotechnics, and the date and hour of radio net opening.

83. Signal Annex

The signal annex to an operation order is prepared when the signal instructions are too voluminous to be included in paragraph 5 of the operation order. The signal annex is based on the signal plan and is made as short as possible by referencing routine signal instructions contained in the standing operating procedures. The signal annex, which follows the format of the operation order, includes information and instructions that directly affect signal support. A signal annex becomes a part of the commanders' operation order, even though it may be distributed at a different time and receive different distribution. A comprehensive SOP and SOI-SSI will minimize the need for a signal annex.

84. Standing Operating Procedure

An SOP (standing operating procedure) is a set of instructions giving the procedure to be followed by a particular unit in performing those operations, both tactical and administrative, that the commander desires to be routine.

a. Purpose of a Signal SOP. The purpose of a signal SOP is to—

- (1) Gain speed and precision in operations by standardizing the operating methods, procedures, and techniques.
- (2) Simplify and perfect the training of all personnel.
- (3) Reduce the number and length of signal orders.
- (4) Simplify staff planning.
- (5) Facilitate control and coordination of effort at all levels of command.
- (6) Promote teamwork.
- (7) Enable all members to understand what the rest of the unit will do under certain circumstances.

(8) Reduce the number of minor decisions to be made by the commander and his subordinates.

b. Form and Content. Signal SOP's are prepared in accordance with the format described and illustrated in FM 101-5. In addition, a checklist for preparation of a field artillery unit SOP is shown in FM 6-20-2. The content of the signal SOP will depend on the desires of the commanding officer, the recommendations of the communication officer, the SOP of the next higher headquarters, and the state of training of the command.

c. Flexibility. A signal SOP must be revised from time to time as the training of the unit progresses in order to eliminate superfluous details and to insure the development of concise, final instructions suitable for contemplated operations.

d. Use of the Signal SOP. The signal SOP should have widespread distribution within the unit. All key operating personnel should know the signal SOP of the unit, since it affects not only communication personnel but also users of the communication systems.

85. Signal Operation Instructions

a. General. The signal operation instructions (SOI) consist of technical instructions, subject to frequent change, that are required in the employment of signal communications. The SOI generally is prepared and issued by the signal officer at a headquarters of division level and above. Radio frequencies and call signs may be assigned to corps artillery and division artilleries in blocks, and the communication officers of these commands will be required to prepare an extract SOI assigning frequencies and call signs to subordinate units. Units authorized transmission equipment should be assigned noninterfering frequencies, as shown in the applicable technical manuals.

b. Distribution. Distribution of the signal operation instructions is made to subordinate units, next higher headquarters, and the headquarters of adjacent commands. Certain items of the SOI should be extracted and given wide distribution within the unit.

c. Classification. Each portion of the SOI is classified according to its content, as prescribed by AR 380-5 and AR 380-40. The classification is marked or stamped at the top and bottom of each page of the classified portion. The assembled SOI is assigned the same classification as the portion with the highest classification.

d. Security. SOI's include information that is of particular value to the enemy because it could serve as a means of gaining additional intelligence. Therefore, the complete SOI of any echelon should not be taken forward of the command post of the echelon to which it is issued. When an SOI or an extract is compromised, the fact must be reported and the SOI must be replaced immediately. For information concerning the storage of classified material, see AR 380-5 and AR 380-40. A record should be maintained of all extracted portions of an SOI, and personnel within units should be instructed to destroy these items if capture is imminent.

86. Standing Signal Instructions

The standing signal instructions (SSI) contain operating instructions, not subject to frequent change, that are required in the employment of signal communications throughout the issuing command. The SSI includes instructions that explain the various procedures to be followed in using the individual items of the SOI. When no SSI is published, these instructions are incorporated in the SOI.

a. Distribution. Items of the standing signal instructions receive the same distribution as SOI items. The signal officer may make additional distribution, when necessary.

b. Classification. The SSI is classified in the same manner as the SOI.

87. Routine Signal Orders

To insure coordination of signal communications throughout the command, it is necessary from time to time to issue routine signal orders. These orders are prepared by the staff communications officer and contain information and instructions of general and more than temporary interest. The following subjects might be covered in routine signal orders:

a. Changes in allowances of equipment.

b. Correction of abuses in the use of equipment and services.

c. Deficiencies in training and operations.

d. Standing operating procedure.

e. Supply and maintenance instructions.

CHAPTER 8

THE FIELD MESSAGE

88. General

a. In field artillery units, messages should be prepared on blank message forms (figs. 5 and 6) which are requisitioned and issued as DA Form 11-170 (Message Book). In the field, this book usually is referred to as Message Book M-210. The procedures given in this chapter apply when the message book is used and also when the form is not available and the drafter must improvise. The basic rules of message preparation and the description of elements of a message will apply to any message form.

b. Message preparation is not confined to commanders or staff officers. All military personnel, regardless of grade or position, are authorized and may be required to prepare field messages.

c. This chapter describes the procedures and rules for composing a tactical message. The textual part of a message contains the basic idea to be conveyed to the addressee and must be prepared in such a manner that he will fully understand its contents.

89. Basic Rules for Preparing Messages

In the preparation of a message—and this includes writing the text—certain rules must be followed.

a. Writing. Each word must be printed in military block capital letters (except signatures, which must be written in longhand).

b. Abbreviations. Normally, abbreviations will not be used. However, if the writer has reasonable knowledge that the addressee is familiar with certain abbreviations, those authorized by AR 310-50 may be used.

c. Punctuation. Punctuation should not be used unless necessary for clarity. When punctuation is necessary, only the following punctuation symbols may be used: dash or hyphen (-), question mark (?), colon (:), dollar sign (\$), apostrophe ('), period (.), comma (,), slant (/), quotation marks

("), parentheses (), and the letter "X" representing an asterisk.

d. Repetition. Repetition will not be used solely for the purpose of emphasis. It may be used to insure correct receipt of a vital word or an unpronounceable series of unrelated letters. An example in which repetition serves a legitimate purpose is as follows: MIYAZAKI REPEAT MIYAZAKI (to minimize the possibility of mistaken identity or incorrect spelling).

e. Isolated Letters. The phonetic alphabet is used for each isolated letter. Route A, for example, must appear as ROUTE ALFA. The initials of a person's name, however, are never given the phonetic alphabet equivalent.

f. Numbers. Numbers may be written as numerals. Roman numerals will be expressed as cardinal numbers preceded by the word "Roman," e.g., IX should be written as Roman 9.

g. Spacing. If possible, the text should be written on every other line of the message form.

90. Message Form (M-210) (DA Form 11-170)

a. The forms contained in the M-210 message book are arranged in sets of three and are interleaved with carbon paper, thus permitting every message to be prepared in triplicate. When a written message is to be routed through the message center, the number of copies sent to the message center will depend on the unit standing operating procedure.

b. The message form is used whether the message is to be transmitted by electrical means or carried by messenger. If message book M-210 is not available, the drafter may use a plain sheet of paper, but the message format as discussed in paragraph 91 must still be followed.

91. Procedures for Writing the Message

Filling in the message form involves the steps discussed in *a* through *l* below and shown in figure 5.

THESE SPACES FOR MESSAGE CENTER ONLY		
TIME FILED	MSG CEN NO.	HOW SENT
MESSAGE		PRIORITY (PRECEDENCE)
(SUBMIT TO MESSAGE CENTER IN DUPLICATE)		
No. 6		Date 27 FEB 68
To. CO 1ST BN, 17 TH ARTY		
CLASSIFICATION		
FOR S3		
PLAN SIERRA EFFECTIVE 280130S		
CLASSIFICATION		
OFFICIAL DESIGNATION OF SENDER CO 1ST INF DIV ARTY		TIME SIGNED 0815S
SIGNATURE AND GRADE OF WRITER Oscar F Foley LTC, S3		
AUTHORIZED TO BE SENT IN CLEAR <i>John A. Smitty, CPT</i>		

Figure 5. Completed field message.

a. Precedence. The assignment of precedence to a message is the responsibility of the originator. To the drafter, precedence means the required speed of delivery to the addressee. The drafter determines the precedence on the basis of the contents of the message and the time factor involved. He must select the lowest adequate precedence. To communication personnel, precedence means the relative order of handling and delivery. To the addressee precedence indicates the order in which he notes or reads a message. The four precedence designations are shown in table 1. The precedence will not be taken for granted; one of the authorized designations must be used.

Table 1. Precedence Designation

Precedence designation	Example of use
FLASH -----	Flash precedence is reserved for initial reports of enemy contact or for operational combat messages of extreme urgency.

Table 1. Precedence Designation—Continued

Precedence designation	Example of use
IMMEDIATE	Reports amplifying initial enemy contact. Urgent intelligence and/or operational combat messages, all fire missions are automatically assigned a precedence of "Immediate." Reports of warning of grave natural disaster (earthquake, flood, storm, etc.).
PRIORITY -----	Messages concerning the conduct of operations in progress. Urgent administrative messages.
ROUTINE -----	Messages concerning normal peacetime military operations. Operational plans concerning projected operations.

Note. The above four precedences have been approved for U.S. joint usage. Allied countries may use six precedences—FLASH, EMERGENCY, OPERATIONAL IMMEDIATE, PRIORITY, ROUTINE, and DEFERRED. When correspondence is with allied nations, EMERGENCY would be transmitted after FLASH and before OPERATION IMMEDIATE, OPERATIONAL IMMEDIATE would be transmitted after EMERGENCY and before PRIORITY, and DEFERRED would be transmitted after ROUTINE.

TIME FILED

MSG GEN NO.

HOW SENT

ROUTINE

MESSAGE (SUBMIT TO MESSAGE
CENTER IN DUPLICATE)

(PRECEDENCE)

No. _____ Date **28 FEB 68**To. **LO *1, 1ST BN, 17TH ARTY**

UNCLASSIFIED

REPORT YOUR LOCATION

UNCLASSIFIED

S-3, 1ST BN, 17TH ARTY
OFFICIAL DESIGNATION OF SENDER**0946S**
TIME SIGNEDSIGNATURE AND GRADE OF WRITER *Henry A Davis,* MAJ, S3

Figure 6. Example of a message when the drafter and the addressee are both on the same commander's staff.

b. Number. The drafter's message number is entered in the space provided after the abbreviation "No." There are no regulations concerning the assignment of this number; each command specifies its own procedures. The message number is not transmitted when the message is transmitted by electrical means.

c. Date. The day, the month (abbreviated), and the year (last two digits), in that order, are centered in the space provided after the word "Date." The first three letters of the month constitute the correct abbreviations.

d. Official Designation of the Addressee. The official designation of the addressee is entered in the space provided after the word "To." The addressee normally is the commander of the unit or command for whom the message is intended.

e. Official Designation of Sender. The official designation of the originator is entered in the appropriate block. The originator is identified as the

sender in the M-210 message form. Normally, the originator is the commander (designated by title and organization) by whose authority the message is sent. He must be distinguished from the drafter who composes the text. The drafter and the originator may or may not be the same person.

f. Originator, Drafter, and Addressee on the Same Commander's Staff. When the drafter and the person for whom the message is intended are on the same commander's staff (fig. 6) for example, when the S3 of a unit sends a message to the liaison officer of the same unit, *d* and *e* above do not apply.

g. Security Classification. AR 380-5 requires that the security classification be marked or stamped (not typed) at the top and bottom of a classified item. The proper security classification—TOP SECRET, SECRET, CONFIDENTIAL, or UNCLASSIFIED—is entered above and below the text of the message. The classification is cir-

cluded to separate it from other elements of the message. If the message contains cryptoinformation, it will be marked in accordance with AR 380-40.

(1) The originator is responsible for the security classification of the message (the originator is identified as the sender in the M-210 message form), but the drafter is responsible for determining the proper security classification of the message in the name of the originator. No assumptions can be made about security. The drafter must separately and independently designate the security classification of each message.

(2) Local SOP will determine how a message will be processed if no classification has been assigned. In an emergency, a message with a classification up to and including SECRET may be sent in the clear (fig. 5). Only the commanding officer or his specifically authorized representative can authorize a message to be sent in the clear. Before a classified message can be sent in the clear, the following conditions must exist:

(a) The unit must be engaged in actual hostilities.

(b) Speed is so essential that time cannot be taken to encode the message.

(c) The transmitted information cannot be acted on by the enemy in time to influence current operations.

h. Encrypted for Transmission Only.

(1) In the interest of transmission security, it is sometimes necessary to encrypt certain unclassified messages to prevent disclosure of their textual contents. Such messages requiring this protection are designated EFTO (encrypted for transmission only).

(2) If a message drafter is applying the EFTO procedures, the abbreviation UNCLAS EFTO is marked or stamped immediately above and below the text of the message in the M-210 message form.

i. Text. The text of a message must be clear, accurate, and brief. As few words as required for clarity will be used in the message. Conjunctions, prepositions, and articles, such as a, but, for, in, on, and the, should be eliminated unless essential to the meaning. The text of a message may consist of two parts, the internal instructions and the body.

(1) *Internal instructions.* The internal instructions may consist of any required additional

addressee and originator designations (para 90 and 91) and will begin on the first line of the body of the message form. The word "For" will be used to indicate that the message should be delivered to a specific officer or individual at the location addressed. It is followed by an abbreviated title of the person or office within the agency, command, or installation for whom the message is intended.

(2) *Body.* The body of the message is the basic idea of the originator. The body of the text will follow the internal instructions.

j. Time Signed. The drafter enters the time he signed the message. If he signs the message on the same day shown in the DATE block, he will enter only the hour, minute, and zone suffix. If he signs the message on a day other than that shown in the DATE block, he enters the complete date-time group to show the day of the month, the hour, and the zone suffix.

(1) A sample date-time group is 211415Z. The first two digits (21) indicate the 21st day of the current month. (Two digits are always shown; for days prior to the 10th, a zero is added before the digit. For example, the seventh day would be shown as 07.) The second two digits (14) indicate the hour, and the last two digits (15) indicate the minutes after the hour; Z is a suffix indicating the time zone.

(2) The TIME SIGNED block should bear a time zone suffix to indicate the time zone used. The theater commander may authorize the local suffix for messages that will not leave the time zone in which the theater is located. In other instances, the theater commander may require the use of Greenwich mean time (Zulu time).

k. Signature and Grade of Writer. The drafter signs his name and enters his grade in the block provided.

l. Authorized to be Sent in the Clear. Each classified message to be transmitted in the clear must be authorized separately by the commander of the headquarters transmitting the message or his specifically authorized representative. This authorization is indicated by the statement "Authorized to be sent in clear" followed by the signature and grade of the authorizing person (FM 24-17). This authorization is circled to separate it from the other elements of the message. If the message is not authorized to be sent in the clear, it will be encrypted prior to transmission by electrical means.

CHAPTER 9

MESSAGE CENTER OPERATION

Section I. GENERAL

92. General

The message center of a headquarters is the communication agency which receives, transmits, and delivers messages of record for the commander and the staff of the headquarters which it serves. The message center for a headquarters of a field artillery unit is operated by organic communication personnel. The commander is responsible for establishing message center procedures which will best meet the needs of his unit and yet conform to the specific requirements established by his higher headquarters. Accuracy and speed are the results desired in formulating an operating procedure for a message center. However, security will not be sacrificed to gain speed.

93. Organization of Message Center

a. The tables of organization and equipment (TOE) for field artillery units provide for personnel to operate a message center. These personnel are the—

(1) *Chief message clerk and/or senior message clerk.* The chief and/or senior message clerk supervises all activities of the message center to include cryptography, receipt, transmission, and delivery of all messages processed through the message center.

(2) *Message clerk.* The duties of the message clerk are the same as those of the senior message clerk. He normally acts as code clerk, when required, when both he and the senior message clerk are present in the message center.

(3) *Messenger.* The messenger assists in the operation of the message center. His main duty is to pick up and deliver messages as required.

b. Although not specifically provided by the TOE, certain other personnel are required by duty assignment to work in the message center and should be trained in message center procedures. These personnel are—

(1) *Messengers.* Assigned personnel are detailed as messengers.

(2) *Operators.* Radio and teletypewriter operators are trained in cryptography to assist in processing messages requiring encryption or decryption when message center personnel are not available and to insure 24-hour operation.

94. Forms and Equipment

Certain forms, publications, and equipment are necessary for the efficient operation of a message center. The operation of the message center may be simplified by using the minimum required recording procedures and the maximum communication facilities available to the unit. The required forms are listed in a through c below. These forms facilitate message handling and are used when available.

a. *Message Book (DA Form 11-170).* This form provides a set of blank message forms for writing or recording messages.

b. *Joint Message Form (DD Form 173).* This form is used for messages originating within a headquarters for transmission over the on-line cryptofacilities of a communication center. When a message requires more than one page, DD Form 173-1 (Joint Message Form—Continuation Sheet) is used.

c. *Communication Center Delivery List (DA Form 11-39).* This form may be used as a receipt form for delivery of messages within one's own headquarters (fig. 7). The message may be delivered directly to an individual or to the distribution center in the headquarters.

95. Files and Records

Elaborate records must be avoided. However, pertinent classified and unclassified publications governing the operation of mechanical and electromechanical cipher devices and the control of associated material must be on hand. All message center personnel must be familiar with the instructions included in these publications, and re-

For use of this form, see FM 24-17 and TM 11-190-1; the proponent agency is US Army Strategic Communications Command.

DA FORM 11-39
1 SEP 54

EDITION OF 1 OCT 49 WILL BE USED UNTIL EXHAUSTED

* GPO 1962 O - 647139

AGO 7808A

COMMUNICATION STATUS LOG										DATE	
UNIT					TIME ZONE					PAGE NO.	NO. OF PAGES
UNITS TO WHICH CONNECTED	AM RAD		FM RAD		TT		TEL		VHF		REMARKS
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	

DA FORM 2150-R, 1 Dec 64

Replaces edition of 1 Aug 58

Figure 8. Communication Status Log (DA Form 2150-R).

Figure 9. Message Center Log (DA Form 2151-R).

[illegible]

sponsible commanders must insure strict compliance with these directives. Additional records that may be required are listed in *a* through *f* below.

a. Pending File. The duplicate clear text copy or skeleton copy of each outgoing message processed by the message center is placed in the pending file. This copy remains in the pending file until a receipt is obtained from the receiving headquarters. It is then indorsed and placed in the cleared file.

b. Cleared File. The cleared file consists of the duplicate copies of all receipted outgoing messages and completed receipt forms. This file is turned over to the S1 or other designated person by the communication officer at frequent intervals (usually daily) so that messages may be included in the unit journal or other official records of the headquarters.

c. Message Clerk's File. The message clerk retains on file the original clear text copy of each outgoing cryptogram and the original cryptographed copy of each incoming cryptogram. Care must be taken to insure that the clear text copy and the cryptographed copy of a single message are never filed together. These files are disposed of as directed by the communication officer. The message cryptolog is maintained by the message clerk or teletypewriter (or radio teletypewriter) operator, who, in certain circumstances, is the cryptographer. The cryptolog is maintained separately for incoming and outgoing messages and reflects messages transmitted and received electrically. This log is used in submitting the encrypted traffic report. The log is disposed of on instructions of the security officer in accordance with AR 345-210 and AR 380-40.

d. Operator's File. The file kept by the radio and teletypewriter operators contains a copy of each

message sent or received. The file is disposed of as directed by the communication officer.

e. Communication Status Log. The Communication Status Log (DA Form 2150-R) is a record maintained by the message center which shows the current availability of all means of communication used by the message center. It is used to determine the best available routing for messages. The operators of the various communication facilities keep the message center informed of the status of communication with other units. The communication status log (fig. 8) is reproduced locally on 8- by 10½-inch paper. The log is closed out at 2400 hours daily and a new log opened at 0001 hours. Only existing available communication is shown on the new log. The old log is placed in the dead file.

f. Message Center Log. The Message Center Log (DA Form 2151-R) is a daily chronological record of all messages handled by the message center. A separate log is maintained for incoming and outgoing messages. The logs are closed as of 2400 hours daily. Any message not yet receipted for must be checked to insure that the message has been received by the addressee. When all messages have been cleared, the log is placed in the dead file. The message center log (fig. 9) is reproduced locally on 8- by 10½-inch paper.

96. Unit COMSEC Custodian and COMSEC Officer

The unit COMSEC custodian and COMSEC officer should have a detailed knowledge of the regulations governing the maintenance of cryptographic records and reports and of physical security requirements. These officers must be thoroughly familiar with the following partial list of references: AR 380-5, AR 380-40, AR 380-46, and AR 345-210.

Section II. HANDLING OUTGOING MESSAGES

97. Outgoing Messages by Special Messenger (Clear Text)

a. Origin. The outgoing message is prepared by the writer and submitted to the message center in sufficient copies.

b. Processing. The message center clerk enters the time the message was filed, the message center number, and how the message was sent in the spaces provided on all copies of the message form. The duplicate or skeleton copy is placed in the pending file. A delivery list (fig. 10) is prepared when the original is ready for delivery.

c. Dispatch of Messages. The delivery list and the messages for delivery are given to the messenger. Prior to dispatch, the messenger should be instructed concerning—

- (1) The route to follow.
- (2) The importance of the message (if applicable).
- (3) Whether or not to wait for an answer to the message.
- (4) Other information concerning the delivery of the message.

the operator to the addressee. When the addressee station receipts for the message, the operator places his initials and the time of receipt on the message. He notifies the message center of the time of receipt and places the message in his operator's file.

e. Recording Receipt of the Message. On receiving the time of receipt from the operator, the message clerk removes the duplicate or skeleton copy from the pending file, indorses it, completes the entry in the outgoing message log, and files the copy in the cleared file.

Section III. HANDLING INCOMING MESSAGES

99. Incoming Messages by Messenger

a. Receipt of the Message. On receiving a message delivered by a special or scheduled messenger, the senior message clerk signs the receipt form and indicates the time received.

b. Processing. The senior message clerk makes the proper entries in the incoming message log, prepares a delivery list, and dispatches the message or messages to the addressee or appropriate staff officer. When the receipt is returned to the message center, the message clerk enters the time of receipt in the incoming message log.

100. Incoming Messages by Radio

a. Receipt of the Message. The operator copies the incoming messages in triplicate on the message form. After receipting for the message to the transmitting station, the operator places his initials and the time of receipt on the message. He files the triplicate copy in his operator's file and forwards the original and duplicate copies to the message center.

b. Processing. The message clerk decrypts the message and copies the clear text version on a message form. The originator and addressee are determined from the radio call sign and entered on the clear text version. Authentication is checked and noted on the message form along with the time of receipt by the operator and the initials of the person who decrypted the message. The original encrypted copy is placed in the message clerks' file. The clear text copy is delivered, and the message is recorded in the incoming message log as indicated in paragraph 95. All worksheets and extra copies of the message are destroyed by burning. The message clerk makes the appropriate entries in his classified file.

101. Message Center SOP

The commander must assure that all message center personnel are familiar with the operational procedures of his message center. To aid the commander in this respect, the communications officer prepares an SOP for message center operations.

CHAPTER 10

RADIOTELEPHONE PROCEDURE—CONDUCT OF FIRE

Section I. GENERAL

102. Introduction

Radiotelephone procedure is used by all branches of the service for command, operations and administration. The field artillery, however, also uses its communication system for conduct of fire. A specific radiotelephone procedure known as the short-phrase, repeat-back method is used for this purpose. Although the conduct of fire procedure may be modified according to the type of fire mission, the basic procedure remains unchanged.

103. Deviations from Normal Procedure

The radiotelephone procedure for the adjustment of artillery fire deviates from the normal communication procedure outlined in ACP 125 and allied publications. Specific deviations are—

a. Limited use of procedure words and divergence from the normal message format. New meanings are given to some procedure words. For example, the word OVER indicates the end of the transmission; another station is expected to transmit next. The word OUT indicates the end of the transmission, but the same station is expected to transmit next. The word OUT also indicates the termination of a read-back.

b. Extensive use of clear or modified clear text.

c. Automatic read-back without the transmission instructions "read back."

d. Elimination of call signs after identities have been established and when no confusion will result. Under certain circumstances, when identification is required, transmissions are identified by the use of call sign suffix numbers only.

104. Automatic Read-Back Method of Transmission

Transmissions are made in short phrases to facilitate the transmission of firing data and to mini-

mize requests for repetition. Each phrase is repeated by the receiving operator exactly as it was received. The length of each phrase or the number of elements of firing data included in each transmission should be commensurate with established procedure and the training and experience of the operators. To insure accuracy, the transmitting and receiving operators must be familiar with the sequence of the conduct of fire.

105. Net Organization

Four frequency modulated (FM) channels normally are allotted to a divisional howitzer battalion performing a direct support mission. These four channels will be assigned as a command/fire direction net (CF), fire direction net 1 (F1), fire direction net 2 (F2), and fire direction net 3 (F3). Since the command/fire direction channel is not primarily intended for fire direction, it will not be discussed further in this chapter. Each battery may operate on a separate fire direction net, which includes a net control station (NCS) at battalion, a liaison officer, and a number of forward observers. (The number of forward observers depends on the type of unit.)

a. Stations normally concerned with the conduct of fire are—

- (1) Each forward observer and air observer.
- (2) Each liaison officer.
- (3) The NCS in the battalion fire direction center (FDC).
- (4) Each battery fire direction center.
- (5) A relay station, when necessary.

b. A fire mission may be conducted by using any combination of radio and wire. This discussion will include examples of fire missions conducted by radio only.

Section II. EXAMPLE MISSIONS

106. Sequence of Transmissions for a Battalion Mission

a. Fire Missions. Fire missions may be initiated by any of the forward observers. The requests are transmitted over the observer's assigned frequency to the NCS operator for that particular frequency.

b. Procedure. The mission illustrated in *c* through *k* below will be a battalion mission with Battery B the adjusting battery and with Battery A and Battery C the nonadjusting batteries. The requesting forward observer is operating on fire direction net 2 (F2).

c. Call for Fire. The radiotelephone operator for the forward observer (INLAND GALL 44) calls the fire direction net 2 NCS (INLAND GALL 18) in the battalion fire direction center, stating that he has a target upon which he wishes to bring fire.

Forward observer -- INLAND GALL 18, THIS IS INLAND GALL 44, FIRE MISSION, OVER

F2 NCS ----- INLAND GALL 44, THIS IS INLAND GALL 18, FIRE MISSION, OUT

These two transmissions correspond to a preliminary call; they are the initial establishment of communication and must be made in this manner for every mission. After the forward observer has been told to send his mission, the call for fire may be sent in short phrases.

Forward observer -- GRID 482902, OVER

F2 NCS ----- GRID 482902, OUT

Forward observer -- DIRECTION 5680, OVER

F2 NCS ----- DIRECTION 5680, OUT

Forward observer -- INFANTRY PLATOON IN OPEN, VT IN EFFECT, ADJUST FIRE, OVER

F2 NCS ----- INFANTRY PLATOON IN OPEN, VT IN EFFECT, ADJUST FIRE, OUT

d. Message to Observer.

F2 NCS ----- BATTALION BRAVO, 4 ROUNDS, TARGET ALFA BRAVO 2022, OVER

Forward observer -- BATTALION BRAVO, 4 ROUNDS, TARGET ALFA BRAVO 2022, OUT

e. Initial Fire Commands. The batteries are alerted by the appropriate battalion NCS that they are to fire the mission. Battery A is notified by F1 NCS; Battery B, by F2 NCS; Battery C, by F3 NCS. All three batteries are notified simultaneously.

F2 NCS ----- BATTERY ADJUST, OVER

Btry B Operator --- BATTERY ADJUST, OUT

F1 NCS ----- BATTERY ADJUST, OVER

Btry A operator --- BATTERY ADJUST, OUT

F3 NCS ----- BATTERY ADJUST, OVER

Btry C operator --- BATTERY ADJUST, OUT

Note. If adequate frequencies are available and are being used, call signs are dropped after establishment of good communications, otherwise all stations will transmit their own suffix numbers only. (See simultaneous missions, para 110b.)

f. Remaining Initial Fire Commands to the Adjusting Battery.

F2 NCS ----- SHELL HE, LOT X, CHARGE 5, FUZE QUICK, OVER

Btry B operator --- SHELL HE, LOT X, CHARGE 5, FUZE QUICK, OUT

F2 NCS ----- CENTER 1 ROUND, BATTERY 4 ROUNDS, VT IN EFFECT, OVER

Btry B operator --- CENTER 1 ROUND, BATTERY 4 ROUNDS, VT IN EFFECT, OUT

F2 NCS ----- DEFLECTION 2891, QUADRANT 360, OVER

Btry B operator --- DEFLECTION 2891, QUADRANT 360, OUT

g. Remaining Initial Fire Commands to the Nonadjusting Batteries. While Battery B was receiving the data in *f* above on fire direction net 2, the nonadjusting batteries were receiving their initial fire commands on fire direction nets 1 and 3.

F1 NCS ----- SHELL HE, LOT X, CHARGE 5, FUZE VT, OVER

Btry A operator --- SHELL HE, LOT X, CHARGE 5, FUZE VT, OUT

F1 NCS ----- BATTERY 4 ROUNDS, DO NOT LOAD, OVER

Btry A operator --- BATTERY 4 ROUNDS, DO NOT LOAD, OUT

F1 NCS ----- DEFLECTION 2976, TIME 20.0, QUADRANT 362, OVER

Btry A operator --- DEFLECTION 2976, TIME 20.0, QUADRANT 362, OUT . . . BATTERY IS LAID, OVER

F1 NCS ----- IS LAID, OUT

F3 NCS ----- SHELL HE, LOT X, CHARGE 5, FUZE VT, OVER

Btry C operator --- SHELL HE, LOT X, CHARGE 5, FUZE VT, OUT

F3 NCS ----- BATTERY 4 ROUNDS, DO NOT LOAD, OVER

Btry C operator --- BATTERY 4 ROUNDS, DO NOT LOAD, OUT

F3 NCS ----- DEFLECTION 2732, TIME 19.0, QUADRANT 361, OVER

Btry C operator --- DEFLECTION 2732, TIME 19.0, QUADRANT 361, OUT . . . BATTERY IS LAID, OVER

F3 NCS ----- IS LAID, OUT

h. Subsequent Corrections and Fire Commands (Adjustment). While the nonadjusting batteries were receiving their initial data, the adjusting battery was proceeding with the adjustment.

Btry B operator ---SHOT, OVER
 Forward observer ---SHOT, OUT . . . RIGHT 100, ADD 400, OVER
 F2 NCS -----RIGHT 100, ADD 400, OUT . . . DEFLECTION 2822, QUADRANT 368, OVER
 Btry B operator ---DEFLECTION 2822, QUADRANT 368, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . DROP 200, OVER
 F2 NCS -----DROP 200, OUT . . . DEFLECTION 2835, QUADRANT 363, OVER
 Btry B operator ---DEFLECTION 2835, QUADRANT 363, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . LEFT 50, ADD 100, OVER
 F2 NCS -----LEFT 50, ADD 100, OUT . . . DEFLECTION 2860, QUADRANT 366, OVER
 Btry B operator ---DEFLECTION 2860, QUADRANT 366, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . RIGHT 10, DROP 50, FIRE FOR EFFECT, OVER
 F2 NCS -----RIGHT 10, DROP 50, FIRE FOR EFFECT, OUT

i. Subsequent Fire Commands (Fire for Effect).

At this time fire-for-effect data is produced for each battery and sent to all batteries simultaneously.

(1) For the adjusting battery.

F2 NCS -----FUZE VT, BATTERY 4 ROUNDS, DEFLECTION 2853, TIME 20.0, QUADRANT 365, OVER
 Btry B operator ---FUZE VT, BATTERY 4 ROUNDS, DEFLECTION 2853, TIME 20.0, QUADRANT 365, OUT

(2) For the nonadjusting batteries.

F1 NCS -----BATTERY 4 ROUNDS, DEFLECTION 2938, TIME 20.0 QUADRANT 367, OVER
 Btry A operator ---BATTERY 4 ROUNDS, DEFLECTION 2938, TIME 20.0, QUADRANT 367, OUT
 F3 NCS -----BATTERY 4 ROUNDS, DEFLECTION 2785, TIME 20.0, QUADRANT 367, OVER
 Btry C Operator ---BATTERY 4 ROUNDS, DEFLECTION 2785, TIME 20.0, QUADRANT 367, OUT

j. Firing for Effect. As the batteries begin to fire for effect, they announce this on their respective fire direction nets.

Btry B operator ---SHOT, OVER
 Forward observer ---SHOT, OUT

Note. The forward observer is informed when the first round in fire for effect has been fired. If the battery which is on his frequency fires first, the forward observer reads back the transmission directly to the battery. If one of the batteries which is not on the forward observer's frequency fires first, the NCS on the forward observer's frequency relays this information to the forward observer.

Btry A operator ---SHOT, OVER
 F1 NCS -----SHOT, OUT
 Btry C operator ---SHOT, OVER
 F3 NCS -----SHOT, OUT

k. Rounds Complete. As the batteries complete fire for effect, they report this on their respective fire direction nets and it is read back by the NCS. When all batteries have completed firing for effect, the NCS working with the forward observer informs the observer that the battalion has completed its fire for effect.

Btry B operator ---ROUNDS COMPLETE, OVER
 F2 NCS -----ROUNDS COMPLETE, OUT
 Btry A operator ---ROUNDS COMPLETE, OVER
 F1 NCS -----ROUNDS COMPLETE, OUT
 Btry C operator ---ROUNDS COMPLETE, OVER
 F3 NCS -----ROUNDS COMPLETE, OUT
 F2 NCS -----BATTALION, ROUNDS COMPLETE, OVER
 Forward observer ---BATTALION, ROUNDS COMPLETE, OUT, END OF MISSION, ESTIMATE 15 CASUALTIES, REMAINDER DISPERSED, OVER
 F2 NCS -----END OF MISSION, ESTIMATE 15 CASUALTIES, REMAINDER DISPERSED, TARGET ALFA BRAVO 2022, OVER

The F2 NCS in making the last transmission above, has in actuality made two transmissions; he has read back to the forward observer his transmission and initiated a transmission to Battery B, giving them end of mission and the target number of the mission. Battery B operator may now answer in one of two ways—he may read back exactly what the F2 NCS has transmitted, or he may omit the forward observer's surveillance. The battery's transmission will depend on the local SOP.

Btry B operator ---END OF MISSION, TARGET ALFA BRAVO 2022, OUT
 F1 NCS -----END OF MISSION, TARGET ALFA BRAVO 2022, OVER
 Btry A operator ---END OF MISSION, TARGET ALFA BRAVO 2022, OUT
 F3 NCS -----END OF MISSION, TARGET ALFA BRAVO 2022, OVER
 Btry C operator ---END OF MISSION, TARGET ALFA BRAVO 2022, OUT

Note. The batteries terminated their transmission with the procedure word OUT because they made the last transmission on their respective fire direction nets. No further transmissions are expected or required in this mission.

107. Sequence of Short-Phrase, Repeat-Back Transmissions

a. Call for Fire. The radiotelephone operator for a forward observer (PALM CRIMSON 24) operating on fire direction net 1 (F1) calls the F1 NCS (PALM CRIMSON 18) in the battalion fire direction center to establish communications and to inform the battalion fire direction center that he has a fire mission.

Forward observer --PALM CRIMSON 18, THIS IS PALM
CRIMSON 24, FIRE MISSION,
OVER
F1 NCS -----PALM CRIMSON 24, THIS IS PALM
CRIMSON 18, FIRE MISSION,
OUT

If a fire mission is already being conducted on fire direction net 1, the battalion S3 may direct the forward observer to change to fire direction net 2 or fire direction net 3. Having been directed to send his mission, the radiotelephone operator for the forward observer transmits the call for fire in short phases, omitting call signs when only one mission is being sent on that channel.

Forward observer --*GRID 4322, OVER
F1 NCS -----GRID 4322, OUT
Forward observer --3445, OVER
F1 NCS -----3445, OUT
Forward observer --DIRECTION 800, OVER
F1 NCS -----DIRECTION 800, OUT
Forward observer --TWO MACHINEGUNS, VT IN EF-
FECT, ADJUST FIRE, OVER
F1 NCS -----TWO MACHINEGUNS, VT IN EF-
FECT, ADJUST FIRE, OUT

**Note.* Normally, eight-place coordinates are sent in two transmissions and six-place coordinates are sent in one transmission.

b. Correction of Errors. If any error is made during the transmission or read-back of any element, the operator announces CORRECTION and transmits the correct version of the element in error.

Forward observer --GRID 4322, OVER
F1 NCS -----GRID 4332, OUT
Forward observer --CORRECTION, GRID 4322, OVER
F1 NCS -----CORRECTION, GRID 4322, OUT

c. Battalion Fire Order. After the call for fire is received, the battalion S3 issues the fire order, pertinent parts of which are transmitted to the forward observer. This is read back by the forward observer.

F1 NCS -----ALPHA, 4 ROUNDS, TARGET
ALFA BRAVO 2012, OVER
Forward observer --ALPHA, 4 ROUNDS, TARGET
ALFA BRAVO 2012, OUT

d. Initial Fire Commands to the Battery.

F1 NCS -----BATTERY ADJUST, OVER
Btry A operator ---BATTERY ADJUST, OUT
F1 NCS -----SHELL HE, LOT HOTEL, CHARGE
5, FUZE QUICK, OVER
Btry A operator ---SHELL HE, LOT HOTEL, CHARGE
5, FUZE QUICK, OUT
F1 NCS -----CENTER 1 ROUND, BATTERY 4
ROUNDS, VT IN EFFECT, OVER
Btry A operator ---CENTER 1 ROUND, BATTERY 4
ROUNDS, VT IN EFFECT, OUT
F1 NCS -----DEFLECTION 2765, QUADRANT
381, OVER
Btry A operator ---DEFLECTION 2765, QUADRANT
381, OUT

When the pieces fire, the operator reports.

Note. Previous establishment of reliable communications between the base set operator, F1, and Battery A operator permits the assumption that reliable communication exists; therefore, call signs and suffix numbers are eliminated.

Btry A operator ---SHOT, OVER

e. Subsequent Corrections and Fire Commands.

Forward observer --SHOT, OUT . . . LEFT 100, DROP
200, OVER
F1 NCS -----LEFT 100, DROP 200, OUT . . . DE-
FLECTION 2784, QUADRANT
365, OVER
Btry A operator ---DEFLECTION 2784, QUADRANT
365, OUT . . . SHOT, OVER
Forward observer --SHOT, OUT . . . ADD 100, OVER
F1 NCS -----ADD 100, OUT . . . DEFLECTION
2787, QUADRANT 373, OVER
Btry A operator ---DEFLECTION 2787, QUADRANT
373, OUT . . . SHOT, OVER
Forward observer --SHOT, OUT . . . LEFT 20, DROP 50,
FIRE FOR EFFECT, OVER
F1 NCS -----LEFT 20, DROP 50, FIRE FOR EF-
FECT, OUT . . . FUZE VT, BAT-
TERY 4 ROUNDS, DEFLECTION
2788, OVER
Btry A operator ---FUZE VT, BATTERY 4 ROUNDS,
DEFLECTION 2788, OUT
F1 NCS -----TIME 20.0, QUADRANT 369, OVER
Btry A operator ---TIME 20.0 QUADRANT 369, OUT
. . . SHOT, OVER
Forward observer --SHOT, OUT
Btry A operator ---ROUNDS COMPLETE, OVER
Forward observer --ROUNDS COMPLETE, OUT . . .
END OF MISSION, MACHINE-
GUNS SILENCED, ESTIMATE 4
CASUALTIES, OVER
F1 NCS -----END OF MISSION, MACHINE-
GUNS SILENCED, ESTIMATE 4
CASUALTIES, TARGET ALFA
BRAVO 2012, OVER
Btry A operator ---END OF MISSION, TARGET ALFA
BRAVO 2012, OUT

108. Sequence of Transmission for Special Situations

The flexibility of conduct of fire procedure permits its modification to meet special situations.

a. Fire for Effect, Precision Fire. The radiotelephone procedure used in the fire-for-effect portion of a precision fire mission is similar to that used in adjustment except that, to avoid possible confusion, the terminating proword is eliminated when spottings are transmitted.

Forward observer --SHOT, OUT . . . ADD 50, FIRE FOR
EFFECT, OVER
F2 NCS -----ADD 50, FIRE FOR EFFECT, OUT
. . . QUADRANT 295, OVER
Btry B operator ---QUADRANT 295, OUT . . . SHOT,
OVER
Forward observer --SHOT, OUT . . . SHORT LEFT
F2 NCS -----SHORT LEFT, DEFLECTION 2810,
QUADRANT 299, OVER

Btry B operator ---DEFLECTION 2810, QUADRANT 299, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . OVER LINE
 F2 NCS -----OVER LINE, DEFLECTION 2812, QUADRANT 297, OVER
 Btry B operator ---DEFLECTION 2812, QUADRANT 297, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . SHORT LINE
 F2 NCS -----SHORT LINE, DEFLECTION 2811, QUADRANT 297, OVER
 Btry B operator ---DEFLECTION 2811, QUADRANT 297, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . SHORT LINE, OVER
 F2 NCS -----SHORT LINE, DEFLECTION 2811, QUADRANT 297, OVER
 Btry B operator ---DEFLECTION 2811, QUADRANT 297, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT . . . SHORT LINE, OVER
 F2 NCS -----SHORT LINE, BASE PIECE 3 ROUNDS, QUADRANT 295, OVER
 Btry B operator ---BASE PIECE 3 ROUNDS, QUADRANT 295, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT
 Btry B operator ---ROUNDS COMPLETE, OVER
 Forward observer ---ROUNDS COMPLETE, OUT . . . SHORT LINE, OVER LINE, OVER LEFT
 F2 NCS -----SHORT LINE, OVER LINE, OVER LEFT, OBSERVE TIME REGISTRATION, OVER
 Forward observer ---OBSERVE TIME REGISTRATION, OUT
 F2, NCS -----TIME 21.0, QUADRANT 295, OVER
 Btry B operator ---TIME 21.0, QUADRANT 295, OUT . . . SHOT, OVER
 Forward observer ---SHOT OUT . . . AIR
 F2, NCS -----AIR, TIME 21.4, QUADRANT 295, OVER
 Btry B operator ---TIME 21.4, QUADRANT 295, OUT . . . SHOT OVER
 Forward observer ---SHOT, OUT . . . GRAZE
 F2, NCS -----GRAZE, OBSERVE 3 ROUNDS, OVER
 Forward observer ---OBSERVE 3 ROUNDS, OUT
 F2, NCS -----BASE PIECE 3 ROUNDS, TIME 21.2, QUADRANT 295, OVER
 Btry B operator ---BASE PIECE 3 ROUNDS, TIME 21.2, QUADRANT 295, OUT . . . SHOT, OVER
 Forward observer ---SHOT, OUT
 Btry B operator ---ROUNDS COMPLETE, OVER
 Forward observer ---ROUNDS COMPLETE, OUT . . . AIR, AIR GRAZE

b. Simultaneous Missions. There are times when it becomes necessary to fire two or more missions simultaneously on the same fire direction net. When this situation arises, it is necessary that stations identify their transmissions in order to avoid confusion. The battalion fire direction center controls all simultaneous mission. *All stations* when receiving or transmitting, *use their own suffix number.* In the example shown below, the battalion fire direction center indicates that Battery

A will fire for FO 1 (24) and that Battery B will fire for FO 2 (44). The transmissions will be made on fire direction net 1. Interruptions should be made in this procedure only during a natural pause. Such pauses are—

(1) After the call for fire and before the first round is fired.

(2) After a report of SHOT (i.e., during the time of flight).

Example—Simultaneous missions

FO 1 ----DARK ERRAND 18, THIS IS DARK ERRAND 24, FIRE MISSION, OVER
 Bn FDC ---DARK ERRAND 24, THIS IS DARK ERRAND 18, FIRE MISSION, 29 AVAILABLE, OVER
 FO 1 ----29 AVAILABLE, OUT
 FO 1 ----DARK ERRAND 29, THIS IS DARK ERRAND 24, FIRE MISSION, OVER
 A FDC ---DARK ERRAND 24, THIS IS DARK ERRAND 29, FIRE MISSION, OUT
 FO 1 ----GRID 432182, DIRECTION 800, OVER
 A FDC ---GRID 432182, DIRECTION 800, OUT
 FO 1 ----TWO MACHINEGUNS FIRING, VT IN EFFECT ADJUST FIRE, OVER
 A FDC ---TWO MACHINEGUNS FIRING, VT IN EFFECT ADJUST FIRE, OUT
 A FDC ---29 5 ROUNDS, TARGET BRAVO JULIET 7829, OVER
 FO 1 ----29 5 ROUNDS, TARGET BRAVO JULIET 7829, OUT
 A FDC ---SHOT, OVER
 FO 1 ----SHOT, OUT
 FO 2 ----DARK ERRAND 18, THIS IS DARK ERRAND 44, FIRE MISSION, OVER
 Bn FDC ---DARK ERRAND 44, THIS IS DARK ERRAND 18, FIRE MISSION, 49 AVAILABLE, OVER
 FO 2 ----44, 49 AVAILABLE, OUT
 FO 2 ----DARK ERRAND 49, THIS IS DARK ERRAND 44, FIRE MISSION, OVER
 B FDC ---DARK ERRAND 44, THIS IS DARK ERRAND 49, FIRE MISSION, OUT
 FO 2 ----44, GRID 422189, DIRECTION 980, SURVEY PARTY IN OPEN, ADJUST FIRE, OVER
 B FDC ---49, GRID 422189, DIRECTION 980, SURVEY PARTY IN OPEN, ADJUST FIRE, OUT
 FO 1 ----24, RIGHT 100, DROP 200, OVER
 A FDC ---29, RIGHT 100, DROP 200, OUT
 B FDC ---49, SHOT, OVER
 FO 2 ----44, SHOT, OUT
 A FDC ---29, SHOT, OVER
 FO 1 ----24, SHOT, OUT
 B FDC ---49, 3 ROUNDS, TARGET BRAVO JULIET 7716, OVER
 FO 2 ----44, 3 ROUNDS, TARGET BRAVO JULIET 7716, OUT
 FO 1 ----24, ADD 100, OVER
 A FDC ---29, ADD 100, OUT
 A FDC ---29, SHOT, OVER
 FO 1 ----24, SHOT, OUT
 FO 2 ----44, LEFT 50, ADD 100, OVER
 B FDC ---49, LEFT 50, ADD 100, OUT
 B FDC ---49, SHOT, OVER
 FO 2 ----44, SHOT, OUT

Note. The missions continue in this manner until one firing unit has completed its task. Thereafter, suffix numbers are omitted.

c. Splash and Standby Procedure. In circumstances in which the warning SPLASH must be transmitted to the forward observer or in which the warning STANDBY must be transmitted to the spotter (SP), the following radiotelephone procedure will apply:

(1) Assume that the forward observer has requested SPLASH from the FDC or that the spotter has requested STANDBY from the fire support ship (FSS). When the guns have been firing, the following will be transmitted:

<i>Field artillery</i>	<i>Naval gunfire</i>
FDC __SHOT, OVER	FSS___SHOT... STAND-
FO____SHOT, OUT	BY, OUT
FDC __SPLASH, OVER	

(2) SPLASH or STANDBY are transmitted 5 seconds prior to the burst of the projectile.

<i>Field artillery</i>	<i>Naval gunfire</i>
FO____SPLASH, OUT	
FO____LEFT 100, DROP	SP____LEFT 100, DROP
400, OVER	400, OVER
FDC __LEFT 100, DROP	FSS___LEFT 100, DROP
400, OUT	400, OUT
FDC __SHOT, OVER	
FO____SHOT, OUT	
FDC __SPLASH, OVER	FSS___SHOT... STAND-
FO____SPLASH, OUT	BY, OUT

Note. In naval gunfire, the transmission SHOT... STANDBY is terminated with OUT, with no read-back required.

d. Relay Procedure. In circumstances in which direct radio contact between the forward observer or spotter and the fire direction center or the fire support ship cannot be established because of distance, terrain, etc., and pending the availability of automatic retransmission equipment, the relay procedure shown below is prescribed and will be used by all concerned, as applicable. Normally, relay is accomplished by the artillery liaison officer and the naval gunfire liaison officer, as appropriate at the combat battalion.

Example—Relay procedure. Assume that direct radio contact cannot be established between the FO and the FDC or the SP and the FSS. However, the artillery liaison officer (DARK ERRAND 76) is able to contact both the FO and the FDC. Similarly, the naval gunfire liaison officer (LOST PARROT 26 OSCAR) is able to contact both the SP and the FSS. If the liaison officer hears no reply to the preliminary call, he will, without instructions or request, transmit as follows:

<i>Field artillery</i>	<i>Naval gunfire</i>
LO____DARK ERRAND	LO___MUSTANG UNION,
18, THIS IS	THIS IS LOST

Field artillery

DARK ERRAND
76, FROM DARK
ERRAND 64,
FIRE MISSION,
OVER
FDC __DARK ERRAND
76, THIS IS
DARK ERRAND
18, FIRE MIS-
SION, OUT
LO____76, OUT

Naval gunfire

PARROT 26
OSCAR, OVER
FSS___LOST PARROT 26
OSCAR, THIS IS
MUSTANG
UNION, OUT
LO___LOST PARROT 26
CHARLIE,
SEND YOUR
MISSION, OVER

With communication now established, the FO and the SP continue with the call for fire.

Note. To permit the originator to correct any mistake made by the relay station, there should be a pause of 5 seconds between the relay station transmission and the read-back.

Field artillery

FO____FROM REGISTRA-
TION POINT 1,
DIRECTION 940,
RIGHT 600,
OVER
LO____76, FROM REGIS-
TRATION
POINT 1, DI-
RECTION 940,
RIGHT 600,
OVER
FDC __FROM REGISTRA-
TION POINT 1,
DIRECTION 940,
RIGHT 600,
OUT

Naval gunfire

SP____TARGET NUM-
BER 1357
BEARING 5460
MILS, GRID
598610, HEIGHT
120, ANTITANK
WEAPONS,
DANGER
SOUTH 800, 2
GUNS MAIN
ARMAMENT,
ADJUST FIRE,
OVER
LO___TARGET NUM-
BER 1357,
BEARING 5460
MILS, GRID
598610, HEIGHT
120, ANTITANK
WEAPONS,
DANGER
SOUTH 800, 2
GUNS MAIN
ARMAMENT,
ADJUST FIRE,
OVER
FSS___TARGET NUM-
BER 1357,
BEARING 5460
MILS, GRID
598610, HEIGHT
120, ANTITANK
WEAPONS,
DANGER
SOUTH 800, 2
GUNS MAIN
ARMAMENT,
ADJUST FIRE,
OUT

The mission continues to be transmitted in this manner until all elements of the call for fire have been received and read back by the FDC.

The relay station reads back that portion of the call for fire transmitted by the FO or the SP and transmits the information to the FDC or the FSS. In field artillery only, the suffix number of the

relay station is retained to insure that the originating and receiving stations are not confused.

Field artillery

FDC __BATTERY 5
 ROUNDS, TAR-
 GET BRAVO
 GOLF 7112,
 OVER

LO----76, BATTERY 5
 ROUNDS, TAR-
 GET BRAVO
 GOLF 7112,
 OVER

FO----BATTERY 5
 ROUNDS, TAR-
 GET BRAVO

Naval gunfire

FSS___GUN TARGET
 LINE 1200 MILS
 GRID, FIRST
 SALVO AT
 NORTH 800,
 READY, 25,
 OVER

LO----GUN TARGET
 LINE 1200 MILS
 GRID, FIRST
 SALVO AT
 NORTH 800,
 READY, 25, OUT

SP----FIRE, OVER

Field artillery

GOLF 7112,
OUT

LO----76, OUT

Naval gunfire

LO----FIRE, OUT

The mission continues to be transmitted, relayed, and acknowledged in this manner until it is completed. After the firing units and FDC have completed the fire mission, the LO transmits 76, OUT to inform the FO that no further transmission is expected.

Note. The relay procedure described above illustrates the method employed by an intermediate station in relaying a call for fire. The relay was accomplished without the aid of operating instructions, address designations, etc. However, when necessary, the originating station will use whatever transmission instructions are required to accomplish the mission.

CHAPTER 11

RADIO/WIRE INTEGRATION PROCEDURE

109. General

Most artillery headquarters are authorized radio/wire integration equipment (radio set control AN/GSA-7). This equipment can be connected into a switchboard SB-22 to provide integration of communication between FM radio nets and tactical wire systems. When the AN/GSA-7 is used with the VRC-12 series of radio sets, a 5- to 10-pin adapter cable (CX-7474/U) is necessary.

110. Use

a. Use of the radio/wire integration system should be limited to instances in which communication cannot be established in the normal manner over either FM radio or wire circuits.

b. The switchboard operator is the key to this system, and he must be thoroughly trained. He must have a complete list of radio call words and suffix numbers and telephone directory names and numbers if this system is to operate satisfactorily.

c. The radio/wire integration system may be used for—

(1) Emergency communication between a mobile FM radio station and a unit with access to the telephone system.

(2) Communication between two widely separated FM stations which are beyond normal FM range.

(3) Voice communication between mobile units in forward division areas and units located in the division rear.

(4) Communications between low-flying army aircraft and flight control elements that have access to multichannel links of the division communication system.

(5) Supplementing communications between air liaison officers and forward air controllers.

(6) Communication between subordinate and higher headquarters during displacement.

(7) Connecting two switchboards to span a break in a wire line.

(8) Continuation of communication during a river crossing.

111. Procedure

a. Normal radiotelephone procedure will be used when any part of the transmission is sent over the radio portion of the system. Normal telephone or switchboard procedure will be used between the switchboard operator and the telephone user before the wire and radio circuits are interconnected and after they are disconnected. Radio call words and telephone directory names are listed in the SOI-SSI.

b. In the following example, the call originates at a telephone:

(1) The calling party at division artillery (KENNEL 2) asks the switchboard operator (KENNEL OPERATOR) for the battalion commander (KENNEL 6).

Calling party -----KENNEL 6

(2) The switchboard operator repeats the telephone directory name and number exactly as it was given to him by the calling party.

Switchboard operator ----KENNEL 6

Note. At this time the switchboard operator tries to place the call over wire. For this example, we will assume that the called party does not answer.

(3) The switchboard operator notifies the calling party that the called party does not answer.

Switchboard operator ----THIS IS THE KENNEL OPERATOR—KENNEL 6
DOES NOT ANSWER

(4) The calling party decides that he will try to communicate with the called party over the radio/wire integration system. He asks the switchboard operator for the radio/wire integration station (KENNEL 32). Figure 11 illustrates the utilization of radio/wire integration facilities to connect the telephone of the division artillery commander and the radio in the battalion commander's vehicle.

Calling party -----KENNEL 32

(5) Before the switchboard operator connects the calling party with the radio/wire integration station, he advises the calling party as follows:

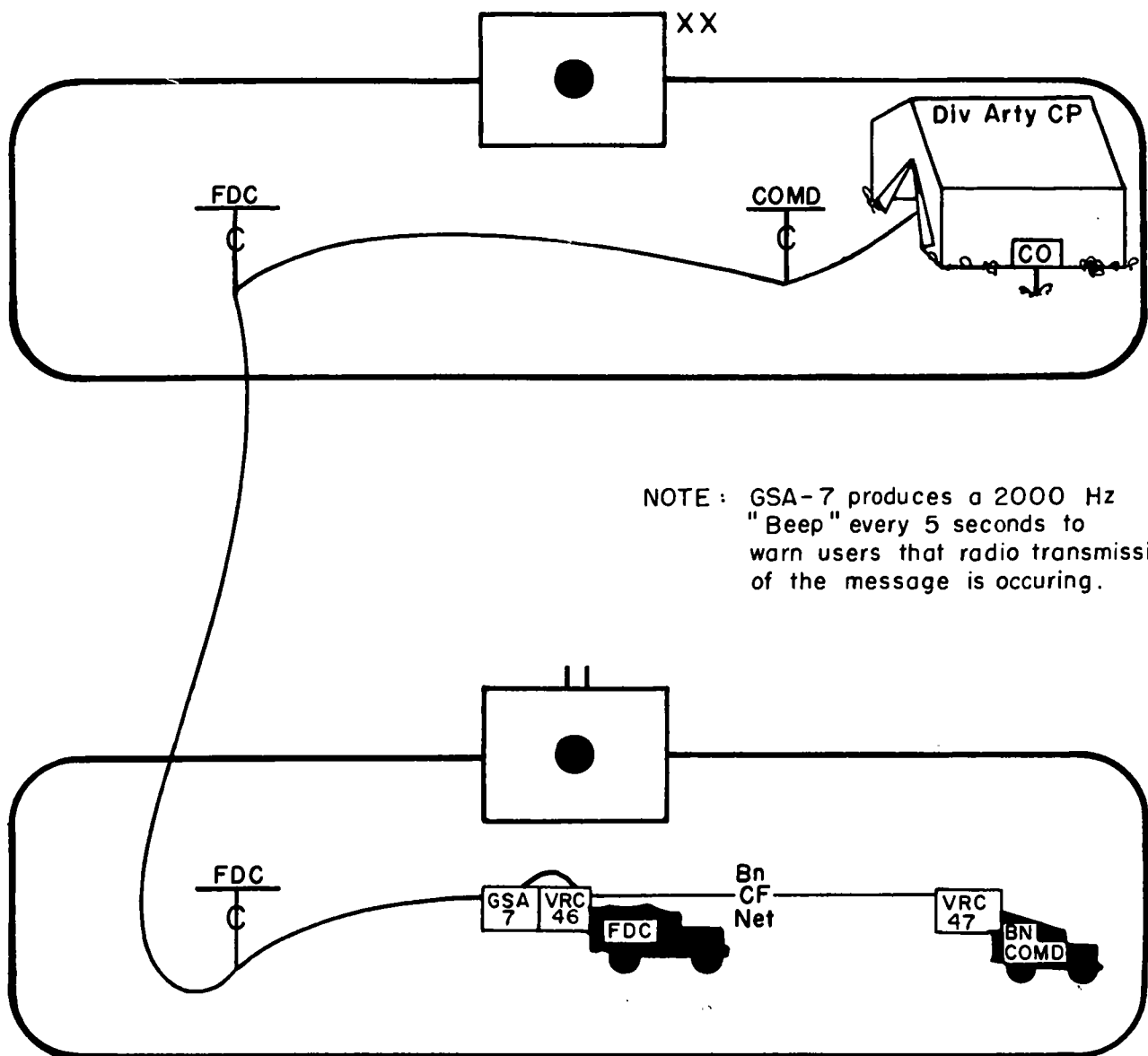


Figure 11. Type utilization of radio/wire integration system.

Switchboard operator ---- KENNEL 32—USE YOUR RADIO CALL WORD AND SUFFIX NUMBER AND STRICT RADIOTELEPHONE PROCEDURE—WHEN YOU HEAR THE RUSHING SOUND, YOU ARE ON THE AIR—MAKE THE INITIAL CALL

Note. It may be necessary for the switchboard operator to give the calling party the radio call word and suffix number.

(6) When the switchboard operator plugs the calling party into the line pack of the radio set control AN/GSA-7, a rushing sound is heard. When the calling party hears the rushing sound, he makes his initial call.

Calling party ----- LUCID BEACON 11—THIS IS LUCID BEACON 14—OVER

(7) The conversation between LUCID BEACON 11 and LUCID BEACON 14 is made by using normal radiotelephone procedure. When the conversation is completed, both stations ring off.

(8) When the stations ring off, the switchboard operator comes back on the circuit to see if either station wishes to talk to anyone else.

Switchboard operator ---- THIS IS LUCID BEACON 28 —OVER

(9) If neither station answers, the switchboard operator breaks down the call. If one of the stations answers the call, the switchboard operator disconnects the party not concerned.

c. In the following example, the call originates at a radio:

(1) The calling party (LUCID BEACON 11) wishes to talk with the division artillery S3 (LUCID BEACON 15). Using the 1600-cycle ring switch on the radio receiver-transmitter RT-67 or the radio frequency oscillator *O-574()/GRA with the radio receiver-transmitter RT-524, the calling party sends out a signal not exceeding 2 seconds in duration. Several switchboards could have a radio set control AN/GSA-7 on this same frequency, in which case the drops on all the switchboards would operate. In this event, the calling party would wait approximately 5 seconds and then make the initial call to the control station (switchboard) with which he wishes to talk.

Call party -----LUCID BEACON 28—THIS IS
LUCID BEACON 11—OVER

(2) When the switchboard operator (LUCID BEACON 28) hears this call, he answers. All other switchboard operators break down the call.

Switchboard operator ----LUCID BEACON 11—THIS IS
LUCID BEACON 28—OVER

(3) When the calling party hears this transmission, he asks the switchboard operator to connect him to the party with whom he wishes to speak.

Calling party -----THIS IS LUCID BEACON 11
—GIVE ME LUCID BEACON 15—OVER

(4) To inform the calling party that he has received the call, the switchboard operator transmits as follows:

Switchboard operator ----THIS IS LUCID BEACON 28
—WAIT (OUT)—

(5) The switchboard operator, without interconnecting the radio and telephone circuits, calls the desired party by telephone, using the tele-

phone directory name and number of the called party. He tells the called party that he has a radio call for him.

Switchboard operator ----KENNEL 3—THIS IS THE
KENNEL OPERATOR—I
HAVE A CALL FOR YOU
OVER RADIO FROM KEN-
NEL 6—USE YOUR RADIO
CALL WORD AND SUFFIX
NUMBER AND STRICT
RADIOTELEPHONE PRO-
CEDURE—WHEN YOU
HEAR THE RUSHING
SOUND, YOU ARE ON
THE AIR—MAKE THE
INITIAL CALL

(6) When the called party hears the rushing sound, he then makes his initial call.

Called party -----LUCID BEACON 11—THIS IS
LUCID BEACON 15—OVER

(7) The calling party transmits his message, and the conversation ends. Both parties ring off, if possible.

(8) When the stations ring off, the switchboard operator comes back on the air to see if either station wishes to talk to anyone else.

Switchboard operator ----THIS IS LUCID BEACON 28
—OVER

(9) If neither station answers, the switchboard operator can break down the call. If one of the stations answers the call, the switchboard operator disconnects the party not concerned.

d. Radio-wire/integration utilizing command nets as the radio portion should be restricted to the use of local wire lines within the command post. Long local or trunk lines where possibility of hostile wire tapping exists will be used only in cases of extreme emergency.

* Authorized by SB 11-602

CHAPTER 12

TELEPHONE AND SWITCHBOARD PROCEDURE

112. General

To effectively utilize the wire communication available to a unit, all persons who use this means of communication should be familiar with the proper procedure and techniques involved in its operation, including the telephone directory, field telephone, and switchboard.

113. Telephone Directory

The purpose of the military telephone directory is to simplify and expedite communication in a field telephone system. The telephone directory consists of two parts, directory names and directory numbers, both of which are found in the SOI-SSI. Telephone directory names are assigned to organizations normally equipped with switchboards. The names are changed when there is a possibility of confusion with directory names of other divisions or units or for security reasons. Command and staff officers and installations *not* normally equipped with switchboards are assigned telephone directory numbers. The military telephone directory is prepared as part of the SOI-SSI by the signal officer of the division or of a higher echelon.

a. Directory Names. Directory names of all major units of a division begin with the same letter. Separate battalions and batteries are assigned separate directory names. Units at battery level use the directory name of their battalion plus the suffix ALFA, BRAVO, or CHARLIE. A separate battery may be assigned a directory name or may be assigned a telephone number as a suffix to the directory name of its parent unit. Directory names should not be used alone but always in conjunction with the appropriate directory number or echelon of the installation being called.

b. Directory Numbers. Telephone directory numbers, once assigned, are not changed. The same number is prescribed for similar officers and offices throughout the command to prevent confusion. A complete list is published in the unit SSI. Telephones are assigned a directory number or are

identified by an appropriate abbreviation or word description of the installation.

114. Telephone Operation

The telephone is used to provide personal contact between two or more individuals. Conversations should be as short as possible. Written messages should not be transmitted by telephone unless it is unavoidable and/or speed is essential.

a. Classification of Calls. There are two types of telephone calls, *urgent* and *routine*.

(1) An urgent call is one that is given precedence over existing circuits to the extent that it warrants interruption of a connection already made. However, one urgent call normally will not interrupt another urgent call already in progress. Urgent calls are reserved for reports containing information which may materially affect plans or change a course of action, such as reports of initial contact with the enemy, amplifying or subsequent enemy contact reports, and artillery fire missions. Normally, only personnel designated by the commander are authorized to place urgent calls; however, in an emergency, anyone may place an urgent call.

(2) Routine calls have no precedence but are handled in the order received by the operator. Routine calls constitute the bulk of the traffic handled over a military wire system. These calls may contain routine information which, although important, does not require special handling. All personnel using the military telephone system are authorized to place routine calls.

b. Placing Calls. In placing a telephone call, the calling party must be familiar with, or refer to, the telephone directory. Switchboard operators should not be required to look up telephone directory names and numbers for the calling party.

(1) In placing an urgent call, the calling party initiates the call, using the operating phrase URGENT CALL FOR. He then announces the called party's telephone directory name and number followed by the operating phrase THIS

IS and his official designation. For example, an urgent call from the liaison officer, 1st Battalion, 3d Artillery, to the battalion commander would be announced to the switchboard operator as URGENT CALL FOR KENNEL 6, THIS IS KENNEL 9.

(2) In placing a routine call, the calling party announces to the switchboard operator the directory name and number of the called party. For example, a routine call from the commanding officer of Battery A, 1st Battalion, 3d Artillery, to the battalion S3 would be announced to the switchboard operator as KENNEL 3. A call for an unlisted telephone, such as the battalion OP, 1st Battalion, 3d Artillery, would be announced to the switchboard operator as KENNEL OP.

c. Response. In response to telephone calls, the answering party should state the directory name and number of the telephone and his official designation; for example, KENNEL 6, COMMANDING OFFICER SPEAKING; KENNEL 3, S3 SPEAKING; KENNEL 3, OPERATOR SPEAKING.

d. Conversations. The procedure in person-to-person conversations, other than that used in placing and answering the call, follows no particular pattern of operating words and phrases. The parties connected use normal conversational language. To obtain maximum benefit from the military telephone system, the user should know what he wants to say before he places the call. The use of prepared notes is recommended.

e. Oral Messages. The transmission of an oral message differs from person-to-person conversation in that the persons transmitting and receiving the message usually are neither the originator nor the addressee. An oral message normally is not written on the prescribed message form or submitted to the message center for transmission, but, since a third person is involved, operating words and phrases are used. For example, after the calling and called parties have been connected, the phrase MESSAGE FOLLOWS is used by the transmitting operator to alert the receiving operator that a message which requires recording is about to follow. Procedure words and phrases, such as READ BACK, I READ BACK, THAT IS CORRECT, WRONG, SAY AGAIN, I SAY AGAIN, ROGER, OVER, OUT, etc., are used by both parties when applicable.

(1) Assume that the S3, 1st Battalion, 3d Artillery, tells his operations sergeant to call the

commanding officer of Battery A and give him the following information HAVE SURVEY DETAIL CONSISTING OF FOUR MEN AND ONE VEHICLE REPORT TO POINT XRAY AT 1320 SIERRA. The operations sergeant, using the S3 phone, rings the switchboard operator and says KENNEL ALFA 6.

(2) The switchboard operator puts the call through, and the battery commander's operator answers KENNEL ALFA 6, OPERATOR SPEAKING.

(3) The operations sergeant then transmits THIS IS KENNEL 3, OPERATIONS SERGEANT SPEAKING, MESSAGE FOLLOWS, READ BACK, HAVE SURVEY DETAIL CONSISTING OF FOUR MEN AND ONE VEHICLE REPORT TO POINT XRAY AT 1320 SIERRA, OVER.

(4) The receiving operator at KENNEL ALFA 6 transmits I READ BACK, HAVE SURVEY DETAIL CONSISTING OF FOUR MEN AND ONE VEHICLE REPORT TO POINT XRAY AT 1320 SIERRA, OVER.

(5) The message was read back correctly, and the operations sergeant transmits THAT IS CORRECT, OUT.

115. Switchboard Operating Phrases

The switching central provides the wire system with flexibility and is the heart of the wire system. It is important that all switchboard operators and communication personnel use a standardized procedure and method in operating the switchboard. A complete list of words and phrases to be used by operators, for all types of operations, are published in ACP 134. A partial list of the more commonly used operating phrases are given in *a* through *m* below.

a. KENNEL OPERATOR—In answering an incoming call, the switchboard operator announces his telephone directory name followed by the word OPERATOR.

b. KENNEL 6—On receiving the number from the calling party, the switchboard operator repeats the telephone directory name and number exactly as it was given to him by the calling party.

c. WHAT NUMBER PLEASE—Phrase used by the operator to request repetition of a number which he has not understood.

d. THE LINE IS BUSY—Phrase used by the operator to report that a local telephone, for

which he has received a call, is already in use or that all trunks to a desired central are in use.

e. KENNEL 6, URGENT CALL—On receiving an urgent call, the switchboard operator repeats the telephone directory name and number followed by the phrase URGENT CALL.

f. ACORN DOES NOT ANSWER—Phrase used by the KENNEL operator to inform the calling party that the called telephone center (ACORN) does not answer.

g. I WILL RING AGAIN—Phrase used by the operator when, in supervising a connection, he is informed that the called party did not answer.

h. WHAT IS YOUR NUMBER PLEASE—Phrase used by the operator if, after supervising a connection, he is given a new number to call by one of the parties but is unable to identify the calling party.

i. HAVE YOU FINISHED—Phrase used by the operator in supervising a connection. He repeats the challenge once more; if no reply is heard, he breaks the connection.

j. CONFERENCE CALL, KENNEL 5, KENNEL 3, KENNEL 2, I WILL CALL YOU BACK—Phrases used by the operator to indicate that he has understood correctly the numbers given to him by the calling party and that, after completing the calls, he will call the originator back as requested.

k. CONFERENCE CALL, KENNEL, 5, KENNEL 3, KENNEL 2, ONE MOMENT PLEASE—Phrases used by the operator to indicate that he has understood correctly the numbers given to him and to hold the calling party on the line while the connection is being completed.

l. CONFERENCE CALL FOR YOU, ONE MOMENT PLEASE—Phrases used by the operator to inform the called party that he has a conference call for him and that there will be a delay in completing the connection.

m. YOUR CONFERENCE CALL, GO AHEAD, PLEASE—Phrase used by the operator to inform the calling party that the connection is complete and conversation may begin.

CHAPTER 13

TRAFFIC DIAGRAM AND LINE ROUTE MAP

116. Traffic Diagram

A traffic diagram is an illustration showing the telephone and teletypewriter circuits existing between switching centrals of a wire system. Long local circuits may also be shown.

a. Preparation. A traffic diagram is prepared at each switching central by the wire chief or chief operator, assisted by the operator on duty. The operator will keep the traffic diagram current during his tour of duty. The traffic diagram may be drawn on the yellow strip provided on the switchboard. Circuits will be tested and determined to be in operating condition before they are recorded on the traffic diagram.

b. Purpose. The traffic diagram is used by the switchboard operator to route calls by the most direct route. A traffic diagram also shows alternate routes if direct routes are busy or out of service.

c. Security. Local security measures will determine the extent of information that will be placed on traffic diagrams.

117. Constructing a Traffic Diagram

Switching centrals are indicated by the appropriate directory name enclosed within a large circle on the traffic diagram (fig. 12). Unit designations may be shown by symbols when security is not jeopardized. Local telephones are represented by a small circle with an identifying abbreviated designation.

a. Trunk circuits are indicated by single lines drawn between the switching centrals.

b. Local circuits are represented by single lines drawn between the appropriate symbols; e.g., a unit directory name enclosed within a large circle represents a switching central, and a small circle identified by the abbreviated designation represents a telephone.

c. The number of channels available is indicated by a number placed along the line between

switching centrals. Simplex circuits and phantom circuits are included as channels only when the switchboard operator can control these circuits; e.g., when the phantom or simplex circuit is terminated through a repeating coil and a line pack.

d. When possible, systems connecting higher, lower, and adjacent units should be included in the diagram.

e. Marginal information is not included in a traffic diagram. However, if a copy of the traffic diagram is to be forwarded to higher headquarters, the copy forwarded should include the—

(1) Name of the diagram.

(2) Unit designation of the originator.

(3) Date and time of preparation.

(4) Authentication. (The communication officer or his authorized representative must sign the traffic diagram before it is forwarded.)

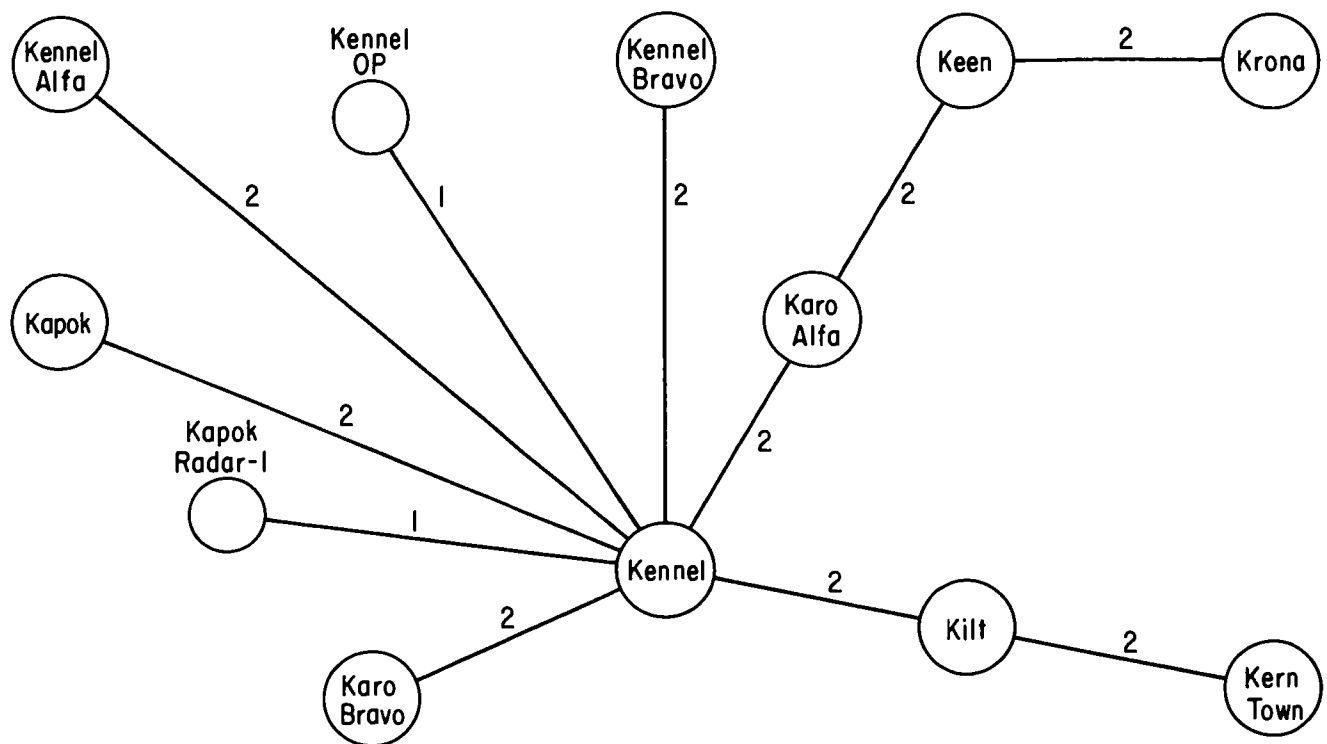
f. Figure 12 represents a traffic diagram prepared by the 1st Battalion, 3d Artillery, to be forwarded to higher headquarters.

118. Line Route Map

a. Definition. A line route map is a map, map substitute, or overlay, suitably titled, on which the actual or projected routes of wire circuits are shown. The line route map does not show the actual connection at the switching central.

b. Uses. The principal uses of the line route map are to report the physical location of wire circuits as actually installed on the ground, to direct the installation of the wire system, to aid in the maintenance of the wire system, to aid in the recovery of wire, and to turn wire circuits over to a relieving unit.

c. Preparation. The battalion communication officer is responsible for the construction, use, forwarding, and safeguarding of the battalion line route map. The line route map is prepared in duplicate. It normally is prepared by the wire chief and checked by the communication chief. When



Telephone Traffic Diagram
1st How Bn, 3d Arty
As of 191300S, Oct 68
W. Shepard
CPT, SC, Commo

Figure 12. Type traffic diagram.

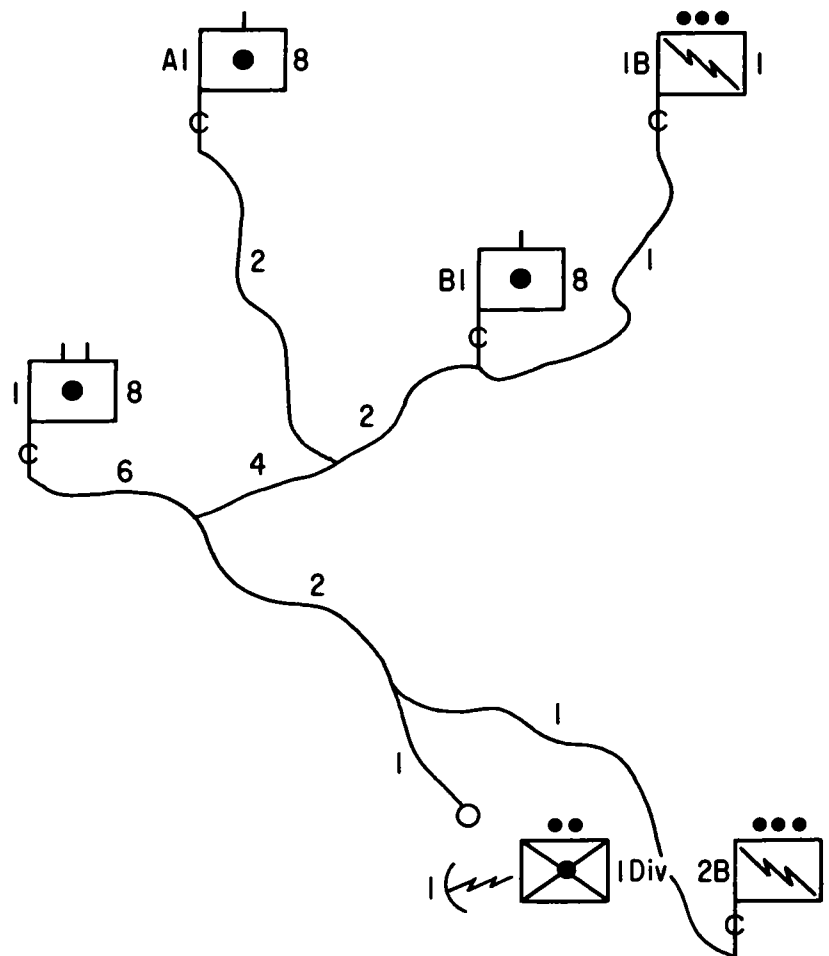
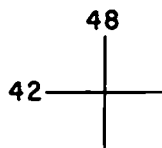
so directed the battery wire team chief prepares the firing battery line route map.

d. Disposition. One copy of the line route map is sent to the next higher headquarters; the other copy is posted in the vicinity of the switchboard of the originating headquarters. Battery line route maps are forwarded as directed or in accordance with local standing operating procedures.

e. Construction. The line route map should contain only those lines, symbols, and notations necessary for clarity. Each headquarters or establishment served by the wire system is shown by the authorized military symbol. Switching centrals, which are part of the wire system, are shown by the authorized military symbol. Telephones, when shown, are represented by a small circle. Trunk-lines and long locals are represented by a single line drawn along the exact route over which the circuit is installed. The number of physical circuits installed along a particular route is indicated

by a number placed next to the line. Simplex and phantom circuits are not shown on the line route map. Field wire circuits indicated on the line route map are laid on the ground unless otherwise indicated. Overhead circuits (TTTTTT) or underground circuits (H-H-H-H) are shown by their appropriate symbol. All line route maps prepared overlay paper must include at least two widely separated orientation points taken from the map from which the overlay was made. The following information will be placed on the line route map wherever space is available:

- (1) The title (Line Route Map).
- (2) The designation of the unit preparing the line route map.
- (3) The date and time of preparation.
- (4) The title and scale of the map.
- (5) Authentication. The line route map normally is authenticated by the unit communication officer signing it.



Line Route Map
 1st How Bn, 8th Arty
 As of 1300 hours,
 19 June 68
 Map-Fort Sill,
 Oklahoma, Sheet
 6353 III NW,
 Scale, 1:50,000
 W. L. Jones
 CPT, SC, Commo

Figure 13. Type line route map overlay.

f. Security. Line route maps normally will not be taken into forward areas. Maintenance crews will carry only the extracts which pertain to their particular mission. Such extracts will not include unit designations.

g. Typical Line Route Map. Figure 13 shows a typical line route map prepared by the 1st Battalion, 8th Artillery.

h. Conversion of Map Distance to Actual Distance. The conversion chart below is a convenient means for converting map distances, measured in inches or centimeters on maps of various scales, into actual distance on the ground. The table can also be used for planning wire installations and estimating the actual amount of wire required for a particular situation.

Map Distance Conversion Chart

Map Distance	Ground Distance	$\frac{1}{25,000}$	$\frac{1}{50,000}$	$\frac{1}{75,000}$	$\frac{1}{100,000}$	$\frac{1}{200,000}$	$\frac{1}{250,000}$	$\frac{1}{500,000}$	$\frac{1}{1,000,000}$
1 Inch	Inches	25,000	50,000	75,000	100,000	200,000	250,000	500,000	1,000,000
	Feet	2,083	4,167	6,250	8,333	16,666	20,833	41,666	83,332
	Yards	694	1,389	2,083	2,778	5,555	6,994	13,888	27,776
	Meters	635	1,270	1,905	2,540	5,080	6,392	12,700	25,400
	Miles	.4	.8	1.2	1.6	3.2	4	8	16
	Kilometers	.64	1.3	1.9	2.5	5.1	6.4	12.7	25.4
1 Centimeter	Inches	9,843	19,685	29,528	39,370	78,740	98,425	196,850	393,700
	Feet	820	1,640	2,460	3,282	6,563	8,204	16,408	32,816
	Yards	273	547	820	1,094	2,187	2,735	5,468	10,956
	Meters	250	500	750	1,000	2,000	2,500	5,000	10,000
	Miles	.16	.31	.46	.62	1.2	1.6	3.1	6.2
	Kilometers	.25	.50	.75	1.0	2.0	2.5	5.0	10.0

CHAPTER 14

COMMUNICATION EQUIPMENT

Section I. INTRODUCTION

119. General

This chapter contains general information concerning communications equipment used in field artillery units. For detailed information pertaining to this equipment and equipment not included in this chapter, see the appropriate technical manuals of the 11-series. Also see the tabulated equipment data in appendix C.

120. Wire Equipment

Wire equipment consists of communications/electronics equipment, including teletypewriter equipment necessary to install, operate, and maintain a unit wire system.

121. Radio Equipment

Radio equipment consists of communications/electronics equipment, including teletypewriter equipment necessary to install, operate, and maintain unit radio nets.

Section II. WIRE EQUIPMENT (EXCEPT TELETYPewriter EQUIPMENT)

122. General

This section contains general information concerning the characteristics of wire equipment used by field artillery units. For operating instructions and detailed information pertaining to this equipment, see the appropriate technical manuals of the 11-series. For detailed information concerning field wire techniques, see FM 24-20.

123. Telephone Cable WD-1/TT

Telephone cable WD-1/TT (fig. 14) consists of two twisted, individually insulated conductors with the following characteristics:

- a. American wire gauge (AWG) No. 23 (each conductor).
- b. Four tinned-copper strands and three galvanized-steel strands (each conductor).
- c. Inner insulation of polyethylene and outer insulation jacket of nylon.
- d. Tensile strength of approximately 200 pounds (both conductors).
- e. Weight of 48 pounds per mile.
- f. Direct current (DC) loop resistance of 200 to 234 ohms per mile at 70° Fahrenheit (F).

- g. Signal loss at 1 kilohertz (kHz) at 68° F of 2.5 decibels (db) per mile under wet conditions or 1.5 decibels per mile under dry conditions.

124. Five-Pair Cable

a. Telephone cable assembly CX-162/G consists of five pairs of rubber-insulated, color-coded, No. 19 AWG, tinned, solid-copper conductors. Cotton cord is used in the center of the cable and as a filler between pairs. A cotton yarn separator is applied over the assembled conductors, and black vulcanized or synthetic rubber is molded around the outside to form the cable jacket. The cable is equipped with a connector on each end.

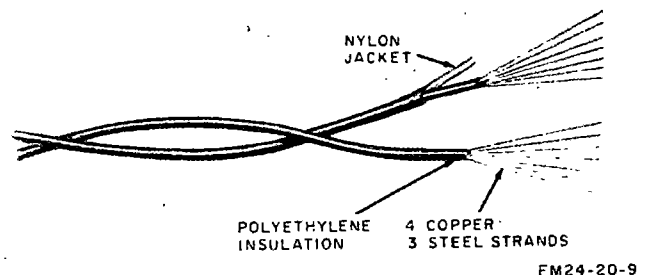


Figure 14. Telephone cable WD-1/TT.

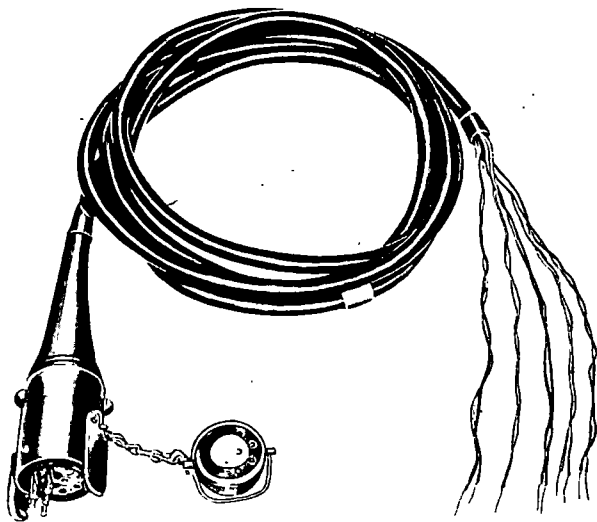


Figure 15. Telephone cable assembly CX-163/G.

b. Telephone cable assembly CX-162/G is furnished in 1/2-mile, and 1,000-, 500-, 200-, and 100-foot lengths. A 12-foot length of telephone cable assembly CX-163/G (fig. 15) has a connector at one end, which connects to a telephone cable assembly CX-162/G, the individual cable conductors are separated to permit connection to binding posts.

c. Five-pair cable is used to facilitate installation to eliminate large numbers of field wire circuits in congested areas where a concentration of communication circuits is required. Five-pair cable is particularly useful for installing circuits from a wirehead, or patching panel, to the switchboard in a command post or as a distribution cable for local circuits.

125. Spiral-Four Cable

a. *General.* Spiral-four cable consists of four separately insulated conductors twisted about a common axis and normally is used to provide a four-wire transmission line for a carrier communication system. It also can be used for long-distance voice-frequency circuits. Detailed information concerning cable assemblies using spiral-four cable (telephone cable WF-8/G) is contained in TM 11-381.

b. *Telephone Cable Assembly CX-1065/G.* Telephone cable assembly CX-1065/G (fig. 16) consists of approximately one-fourth miles (1,280 to 1,360 feet) of spiral-four cable (telephone cable WF-8/G) fitted at each end with a universal connector. A pair of conductors connect the male con-

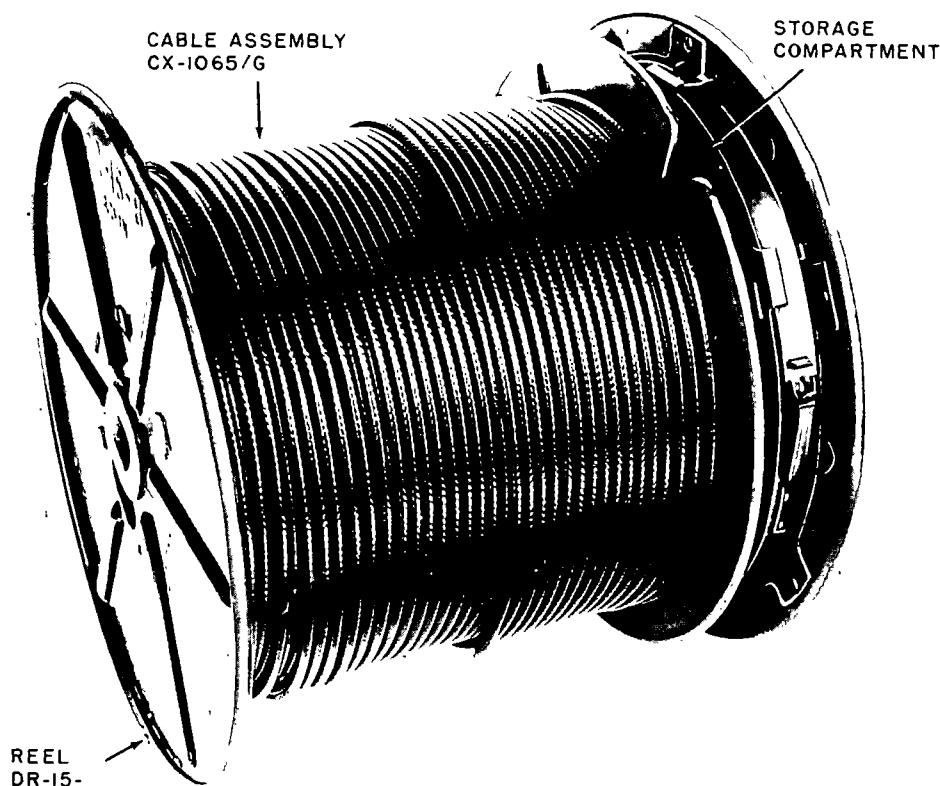


Figure 16. Telephone cable assembly CX-1065/G, wound on cable reel DR-15().

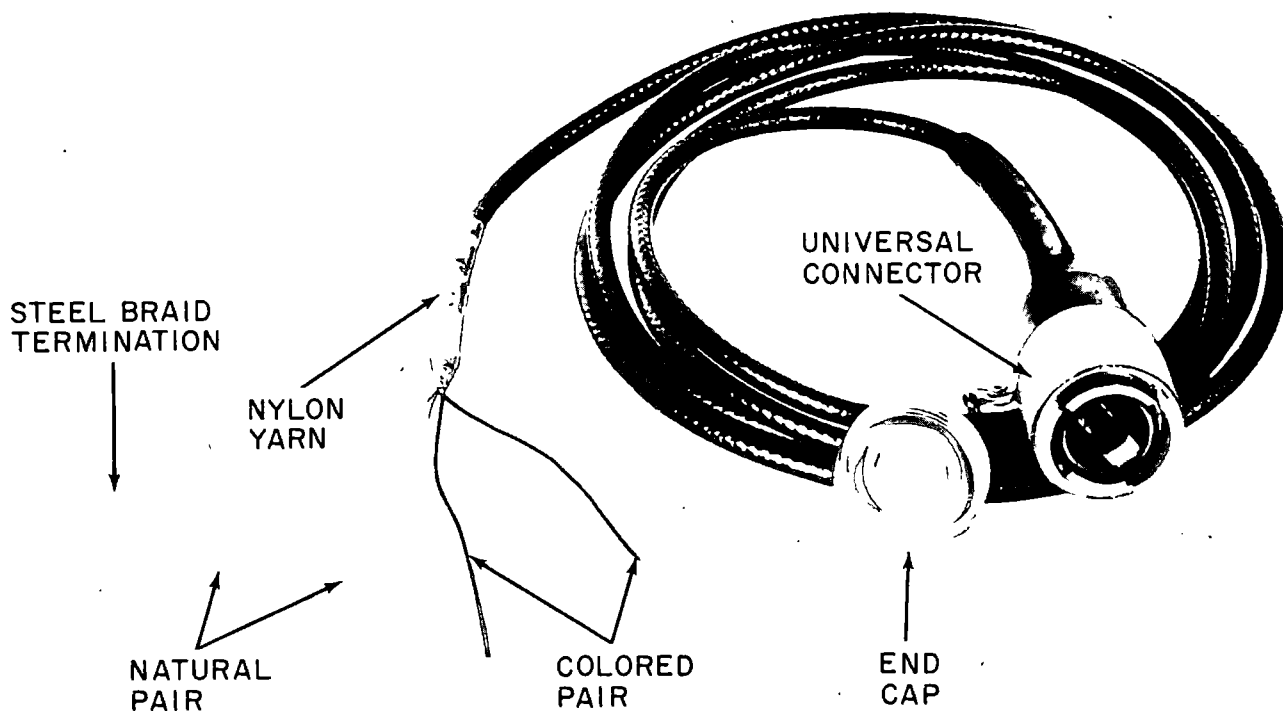


Figure 17. Telephone cable assembly CX-1512/U, special purpose, electrical.

tacts of the connector on one end to the female contacts of the connector on the other end. The steel braid is connected to the connector case at each end. Two or more of these assemblies are joined to form a transmission line of any required length. The cable assembly is supplied on cable reel DR-15(). The storage compartment of the reel holds both connectors plus about 12 feet of the inner end of the cable.

c. *Cable Assembly, Special Purpose, Electrical, CK-1512/U.* Cable assembly CX-1512/U (fig. 17) is a cable stub and consists of 12 feet of spiral-four cable (telephone cable WF-8/G) fitted at one end with a universal connector. The four conductors and steel braid are separated at the other end, allowing the spiral-four cable to be connected to terminal equipment not equipped with universal connectors. The assembly weighs 2 pounds and contains a pair of 6-millihenry loading coils which decrease the cable attenuation on the 0- to 20-kilohertz frequency range. The end cap should be kept screwed on the loading coils when the cable assembly is not in use to protect the faces from moisture, dirt, and damage.

(1) A nylon yarn braid covers the open ends of the steel braid. The steel braid termination is made at the top of the nylon braid for ease of identification.

(2) The conductors are bared about three-fourths of an inch and tinned. The tinned ends prevent fraying of the conductor strands and provide a good electrical connection.

126. Telephone Wire Splicing Equipment

Field telephone wire splices can be made with either telephone cable splicing kit MK-356/G or tool kit TE-33.

a. *Splicing Kit, Telephone Cable, MK-356 ()/G.* Splicing kit, telephone cable, MK-356()/G (fig. 18) is designed for rapidly splicing telephone cable WD-1/TT (standard splice). The kit consists of splicing tool TL-582/U, 4 magazines, a carrying bag, and 200 splicing connectors (sleeves). The kit is 12 inches long and weighs approximately 3½ pounds.

b. *Tool Kit TE-33.* Tool kit TE-33 (fig. 19) is also used for making telephone cable and wire splices. It consists of a holder, carrying, lineman's

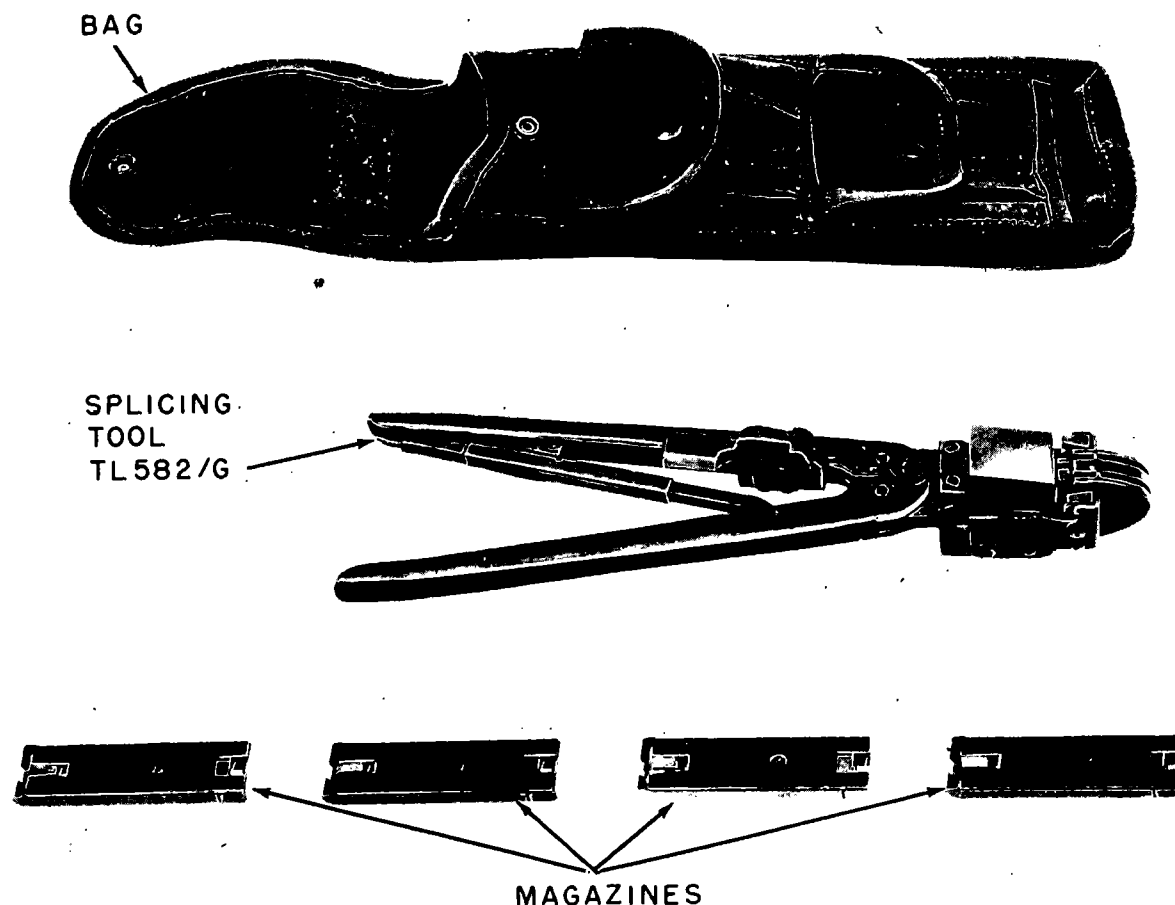


Figure 18. Telephone cable splicing kit MK-356()/G.

pliers, CS-34; pliers TL-13A; and electrician's knife TL-29. Two types of insulating tape can be used in making telephone cable and wire splices—electrical tape TL-636/U (black polyethylene), used in tropical and temperate zones, and electrical insulation tape TL-600/U (white polyethylene), used in the Arctic zone and during cold weather in temperate zones. Tape TL-83 (friction) may be used for added protection of the splice. A small-gage, softdrawn copper wire (known as seizing wire) may be used to improve the splice mechanically and electrically. Seizing wire may be obtained from the copper conductors in a piece of telephone cable.

127. Telephone Cable Reels

The three types of reels (fig. 20) available for use with telephone wire are as follows:

a. Cable Reel DR-5. Cable reel DR-5 is a metal, spool-type container used to store, transport, lay, or recover telephone cable WD-1/TT. It will hold

2½ miles of telephone cable and can be mounted on cable reeling machine, hand, RL-31 or cable reeling machine, engine-driven, RL-207/G.

b. Cable Reel RL-159/U. Cable reel RL-159/U is a metal spool-type container used to store, transport, lay, or recover telephone cable WD-1/TT. The reel will hold 1 mile of cable and can be mounted on cable reeling machine, hand, RL/31; cable reeling machine, hand RL-27; cable reeling machine, motor-driven, RL-172; or cable reeling machine, engine-driven, RL-207/G.

c. Cable Reel DR-8. Cable reel DR-8 is a metal container used to lay or recover telephone wire. The reel will hold one-fourth mile of telephone cable WD-1/TT and can be mounted on cable reeling machine, hand, RL-39.

128. Wire Dispenser MX-306()/G

a. Wire dispenser MX-306 ()/G (fig. 21) is a cylindrical canvas and tape container that holds approximately one-half mile of telephone cable

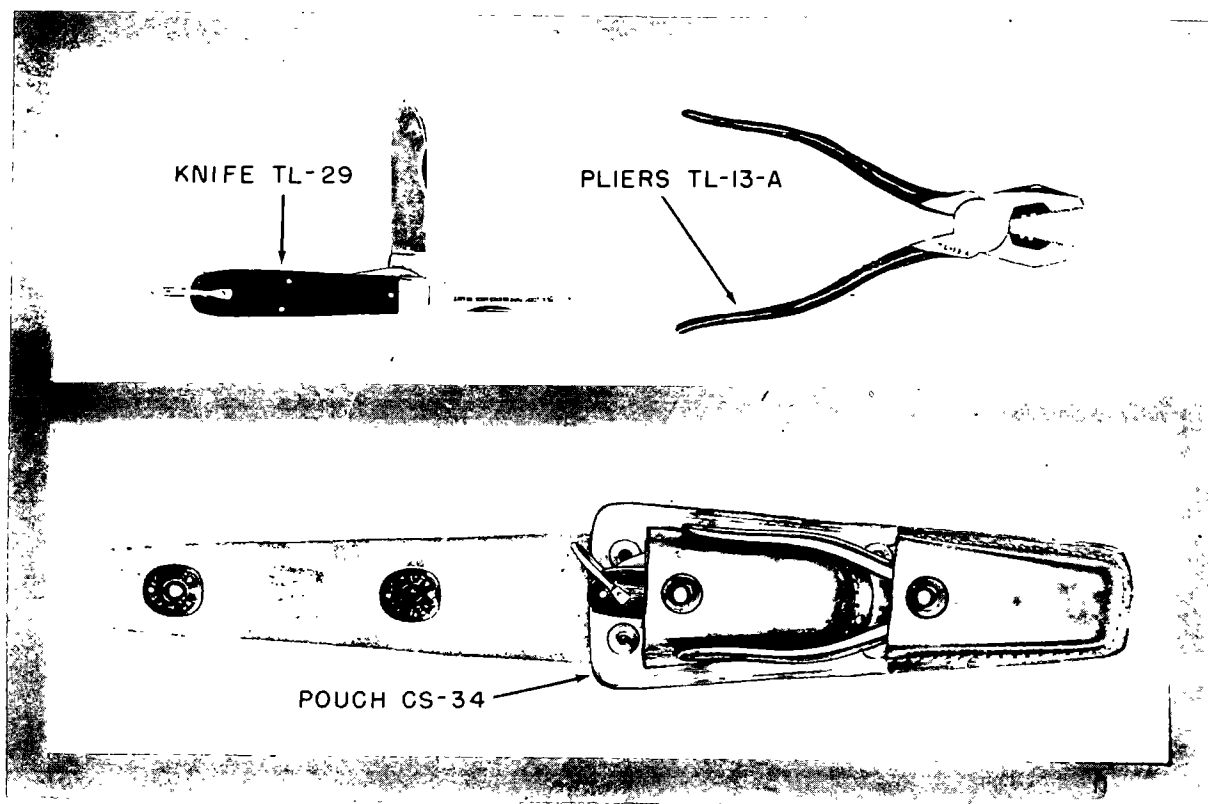


Figure 19. Tool equipment TE-33.

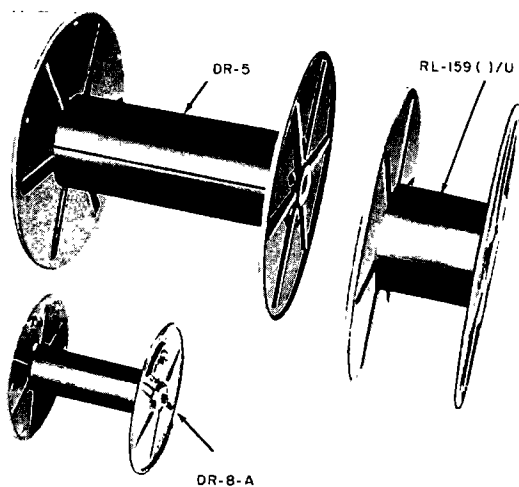


Figure 20. Reels for telephone cable.

WD-1/TT. The telephone cable of two or more dispensers may be prespliced in tandem when it is necessary to lay more than one-half mile of wire without stopping to make a splice.

b. Wire dispenser MX-306()/G has many useful features.

- (1) It is portable.
- (2) It will pay out wire at high speeds from land and amphibious vehicles or from fixed- and rotary-wing aircraft.
- (3) It will function at speeds up to 100 miles per hour.
- (4) It lays the wire flat on the surface of the ground without spirals or kinks.

c. No special mounting devices are necessary if a single dispenser is used to lay the wire. Wire dispenser cases CY-1064/ATC, which holds four dispensers; CY-1064/ATC, which holds five dispensers, and CY-196/ATC, which holds six dispensers, are available for use in laying telephone cable from aircraft. For more detailed information, refer to TM 11-2240.

129. Cable Reeling Machine, Hand, RL-27

Cable reeling machine, hand, RL-27 (fig. 22) is a simple axle designed for laying and recovering telephone cable. The axle is a machined steel bar (2½ feet long) with two knurled handles, one of which can be removed to mount cable reel

(2) A crank for winding the wire or cable on the reels.

(3) A carrying strap for carrying the reeling machine litter style.

(4) A divided axle for use when two reels are mounted on the reeling machine. This axle allows either reel to operate independently of the other. (When the divided axle is used, two cranks and two brakes are necessary for operation. This equipment is issued with the reel unit.)

b. The reeling machine has a capacity of one cable reel DR-5, one cable reel DR-15(), or two cable reels RL-159/U. Cable reels DR-15 are used with cable assemblies.

131. Cable Reeling Machine, Motor-Driven, RL 172/G

a. Cable reeling machine, motor-driven, RL-172/G (fig. 24), which weighs approximately 160 pounds, is used to lay and recover telephone field wire. The reeling machine normally is mounted vertically on the tailgate of a truck but may also be mounted and operated from a horizontal position on the bed of a truck.

b. The reel is driven by a 24-volt DC motor. Power for the motor is furnished by the battery of the vehicle in which the reeling machine is mounted. A vehicle on which the RL-172/G is to be operated should be equipped with a 100-ampere alternator instead of the DC generator, and it must be equipped with a receptacle, slave, 24-volt, waterproof, with cable (FSN 2590-693-4179).

c. A handcrank is provided for manual operation.

d. The reeling machine is designed for one-man operation and is equipped with controls for starting, stopping, and reversing the movement of one cable reel RL-159/U.

e. The telephone cable can be payed out up to a maximum speed of 25 miles per hour and can be

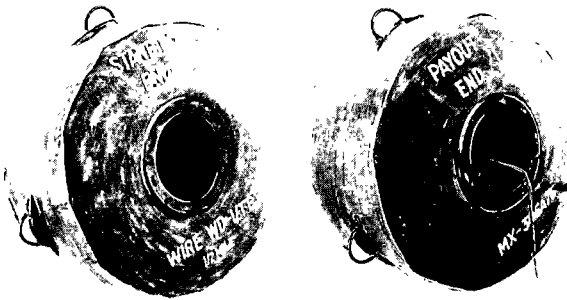


Figure 21. Wire dispenser MX-306A/G.

RL-159/U on the axle. It is equipped with roller bearings and a removable crank, for rewinding the wire. The reeling machine can be carried by two men, or it can be placed on some improvised mounting.

130. Cable Reeling Machine, Hand, RL-31

a. Cable reeling machine, hand, RL-31 (fig. 23) is a lightweight, portable, folding A-frame of steel tubing used for laying and recovering telephone wire and cable assemblies. This reeling machine is equipped with—

(1) A brake unit for controlling the speed of the reels as the wire or cable is payed out.



Figure 22. Cable reeling machine, hand, RL-27.

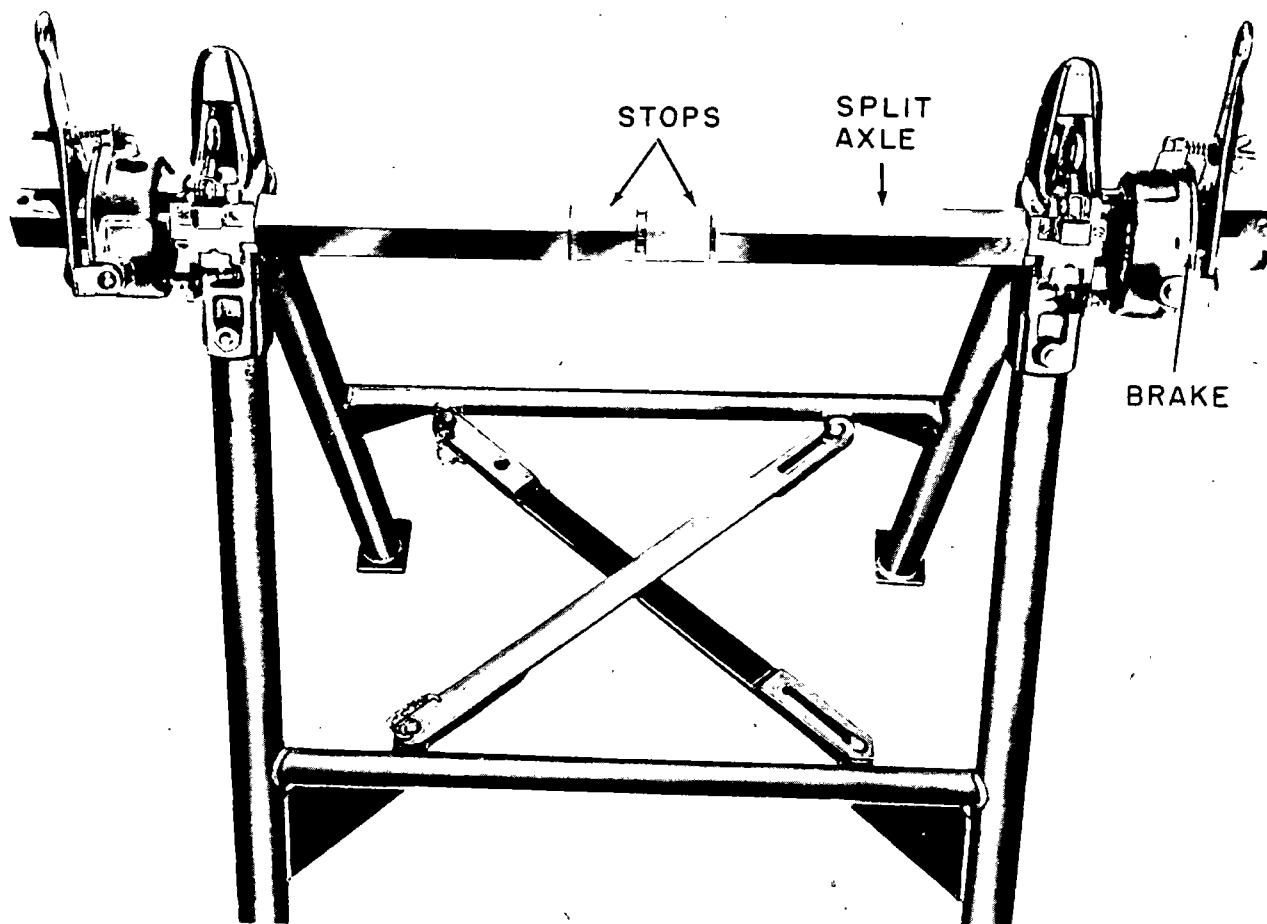


Figure 23. Cable reeling machine, hand, RL-31.

recovered at speeds of 7 to 17 miles per hour. The speed of the reel can be controlled, and the payout speed is determined by the speed at which the vehicle can be safely operated.

f. For complete details on the operation and organizational maintenance of and repair parts for the unit, refer to TM's 11-3895-207-10, -20, and -20P.

132. Cable Reeling Machine, Engine-Driven, RL-207/G

a. Cable reeling machine, engine-driven, RL-207/G (fig. 25) is a transportable, wire and cable laying and recovery machine driven by a gasoline engine. This reel unit, which weighs approximately 490 pounds, normally is mounted in a 3/4-ton or larger vehicle, but it can be operated on the ground. The reeling machine has a capacity of two cable reels DR-5, two cable reels DR-15, or four cable reels RL-159/U.

b. The wire or cable can be payed out or recovered from any reel separately or from all reels simultaneously. Telephone cable WD-1/TT can be payed out at a maximum speed of 25 miles per hour and may be recovered up to a speed of 5 miles per hour. The payout speed is determined by the speed at which the vehicle can be safely operated.

c. For complete details on the operation and organizational maintenance of and repair parts for the unit, refer to TM's 11-3895-209-12 and -20P.

133. Wire Pike MC-123

Wire pike MC-123 consists of a two-section pole joined by metal fittings. The top section terminates in a hook fitted with a roller which is used by wiremen to lay or recover telephone wire. As the wire is payed out, the hook is used to guide the wire along the side of the road. For wire recovery, it provides an even feed and guides the wire to the reeling machine.

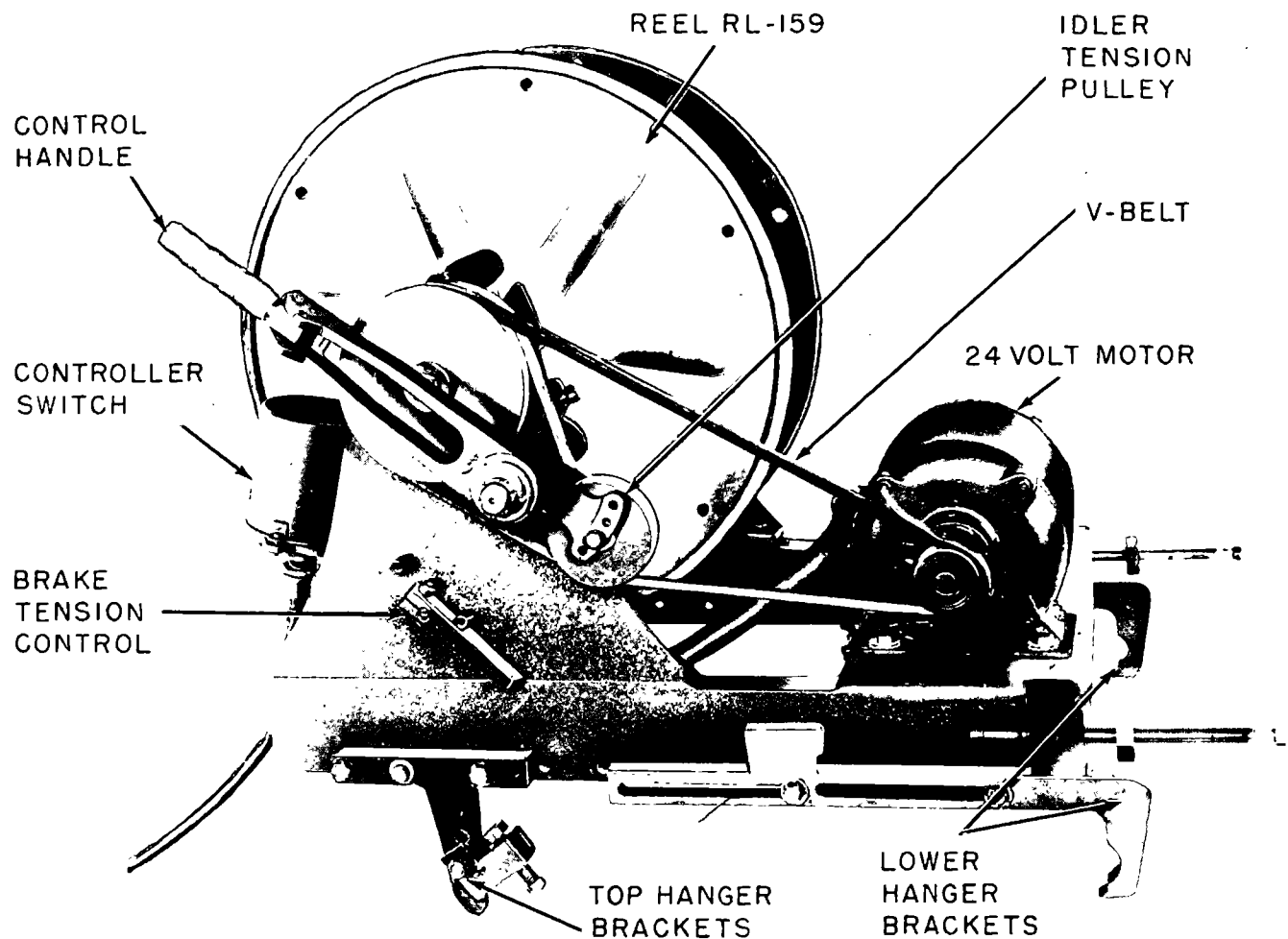


Figure 24. Cable reeling machine, motor-driven, RL-172/G.

134. Climbers LC-240/U

a. General. Climbers LC-240/U (fig. 26) are adjustable, lightweight, metal climbers. The length of the climbers can be adjusted from 14 $\frac{3}{4}$ inches to 19 $\frac{1}{2}$ inches to conform to different leg lengths. Climbers LC-240/U consist of two leg irons, 2-inch and 3-inch interchangeable gaffs, leather fastening straps, and climber pads. The 2-inch gaffs are used for climbing poles or trees with thin bark, and the 3-inch gaffs are used for climbing trees with thick bark.

b. Adjustment. The leg irons can be adjusted by removing the two leg iron screws, moving the slide assembly on the leg iron to the desired length, and inserting and securing the leg iron screws in the nearest screw holes.

c. Gaff Removal. The gaffs can be removed by releasing the two gaff retaining screws and

moving the gaff downward toward the stirrup and lifting it out of the retaining slot. This procedure is reversed to replace the gaffs.

d. Gaff Sharpening. A new gaff may be used as a guide to sharpen dull gaffs; however, gaffs should be sharpened only when replacement gaffs are not available. They must be sharpened on the inside flat surface only, the outside surface must not be touched in order to maintain the proper angle (see FM 24-20).

135. Lineman's Belt LC-23

Lineman's belt LC-23 consists of a leather belt and an adjustable leather safety strap. The body belt is supplied in various sizes, according to the distance in inches between the D-rings. Safety straps are furnished in 61-, 68-, and 70-inch lengths (see fig. 26).

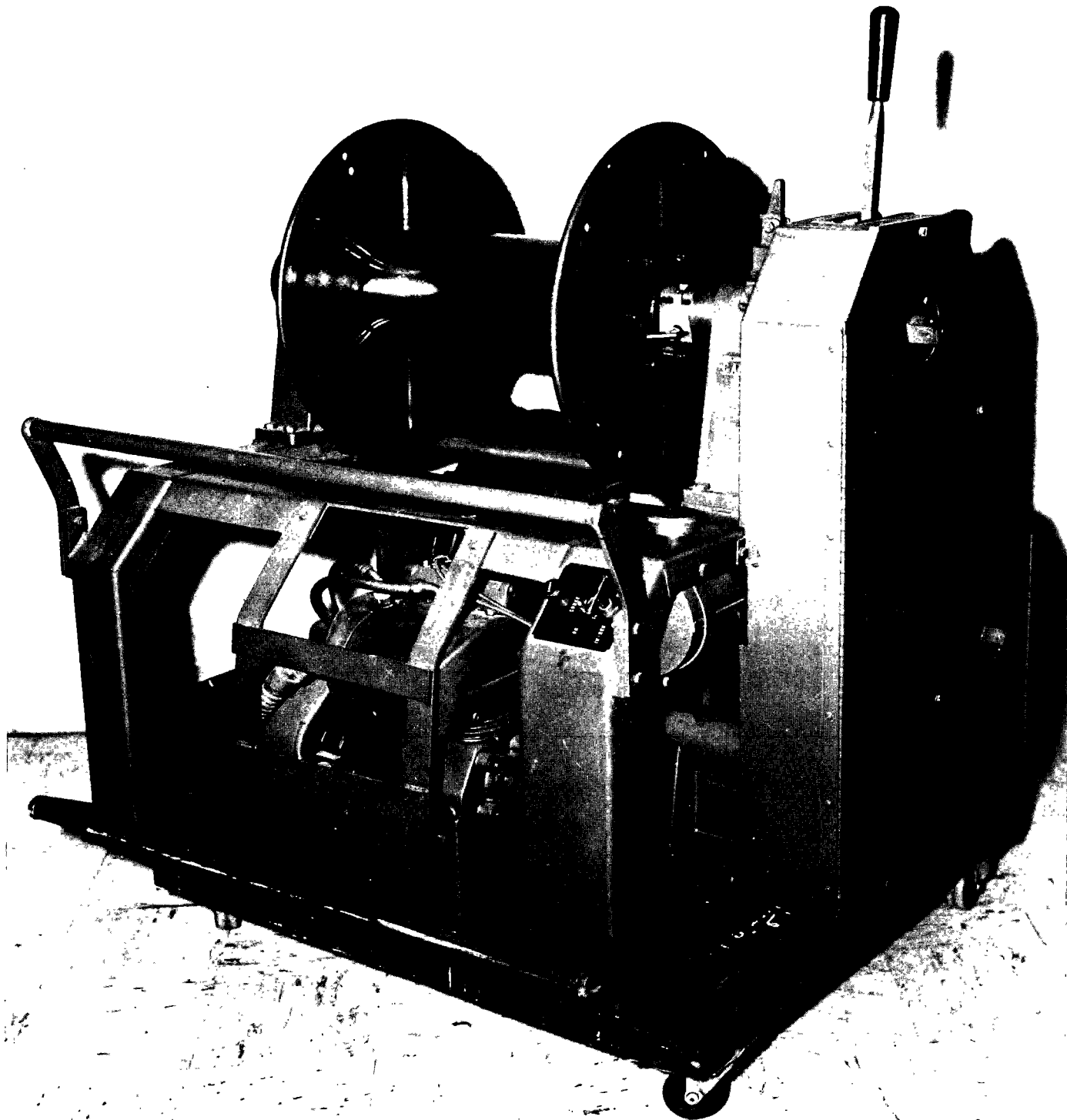


Figure 25. Cable reeling machine, engine-driven, RL-207/G.

136. Field Telephones, General

a. Field telephone sets are portable, self-contained telephones designed for field use. These sets combine durable construction with portability. The specific telephone to be used depends on the length and type of the circuit and the type of switchboard to be used in the circuit.

b. The two principal types of field telephones are sound-powered and battery-powered telephones.

(1) In a sound-powered telephone, the transmitter unit generates the electrical energy. The sound waves created by the voice of the speaker strike the transmitter unit and are converted di-

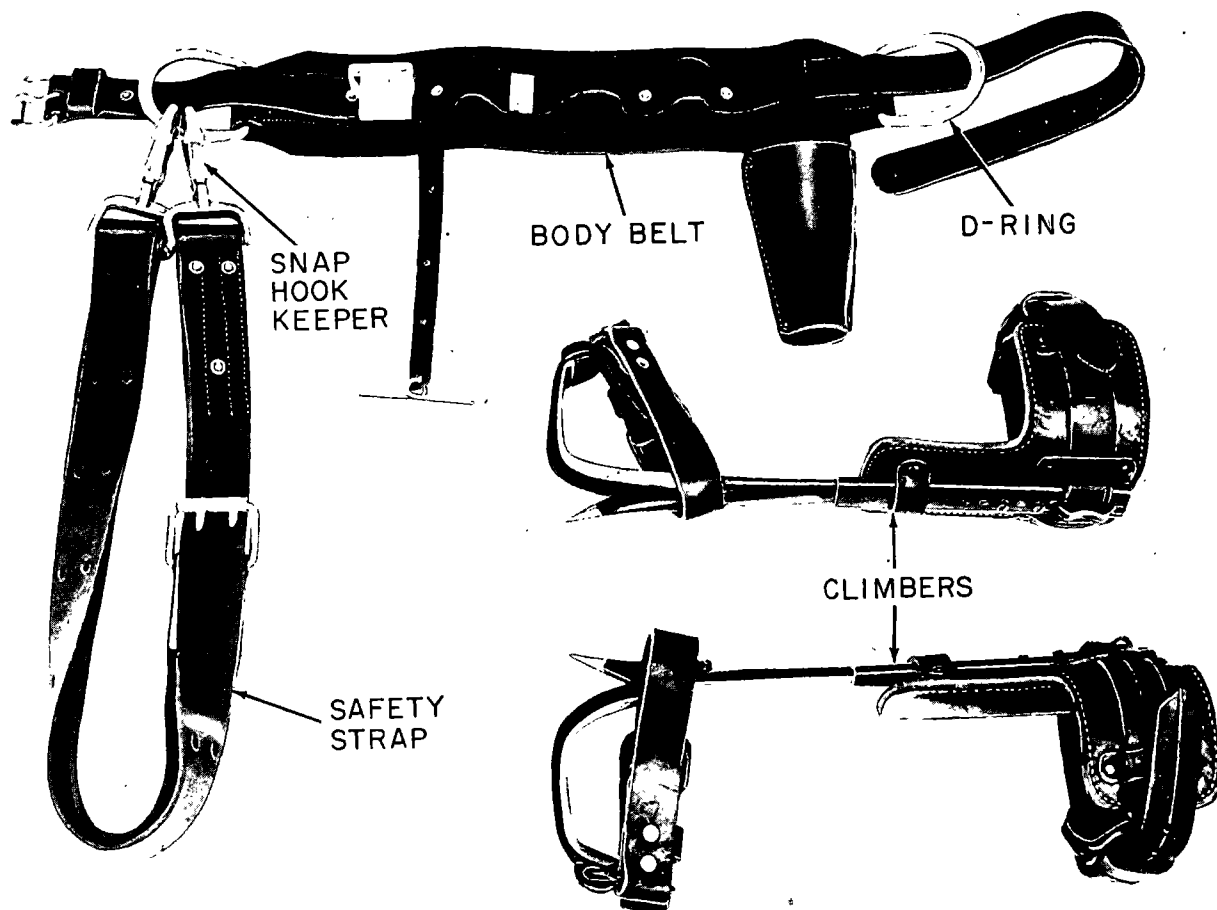


Figure 26. Lineman's equipment.

rectly into electrical energy. The receiver unit of the distant telephone reconverts this electrical energy to the original sound waves. Sound-powered telephones, which have a shorter voice range than battery-powered telephones, can be used with, or in the place of, local-battery telephones. Sound-powered telephones cannot be used in common-battery systems.

(2) In a local-battery-powered telephone, small dry-cell batteries normally contained inside the telephone, are the source of transmission power. When a local-battery-powered telephone is used in a common-battery system, dry-cell batteries inside the telephone may not (depending on the equipment) be necessary. Field telephones contain hand-operated magnetos or ringing generators for signaling. The incoming ringing signals are indicated audibly by a bell or buzzer or visually by a light or silent-type of signal device.

c. The talking ranges of the principal field telephones are summarized, in the following chart:

Field Telephones	Talking distance, using telephone cable WD-1/TT (nonloaded)*	
	Wet conditions km	Dry conditions km
TA-1/PT -----	6.5	16
TA-312/PT -----	22.5	35
TA-264/PT:		
With amplifiers -----	53	96
Without amplifiers -----	19	29

* The above distance are approximate, since talking range is also affected by the number and quality of splices, weather conditions, the number of switching centrals and test stations, noise, crosstalk, and other interference in a circuit.

137. Telephone Set TA-1/PT

a. Telephone Set TA-1/PT (fig. 27) is a sound-powered telephone providing facilities for talking and signaling without batteries. The approximate talking and signaling range of the TA-1/PT is from 6.5 to 16 kilometer over telephone cable

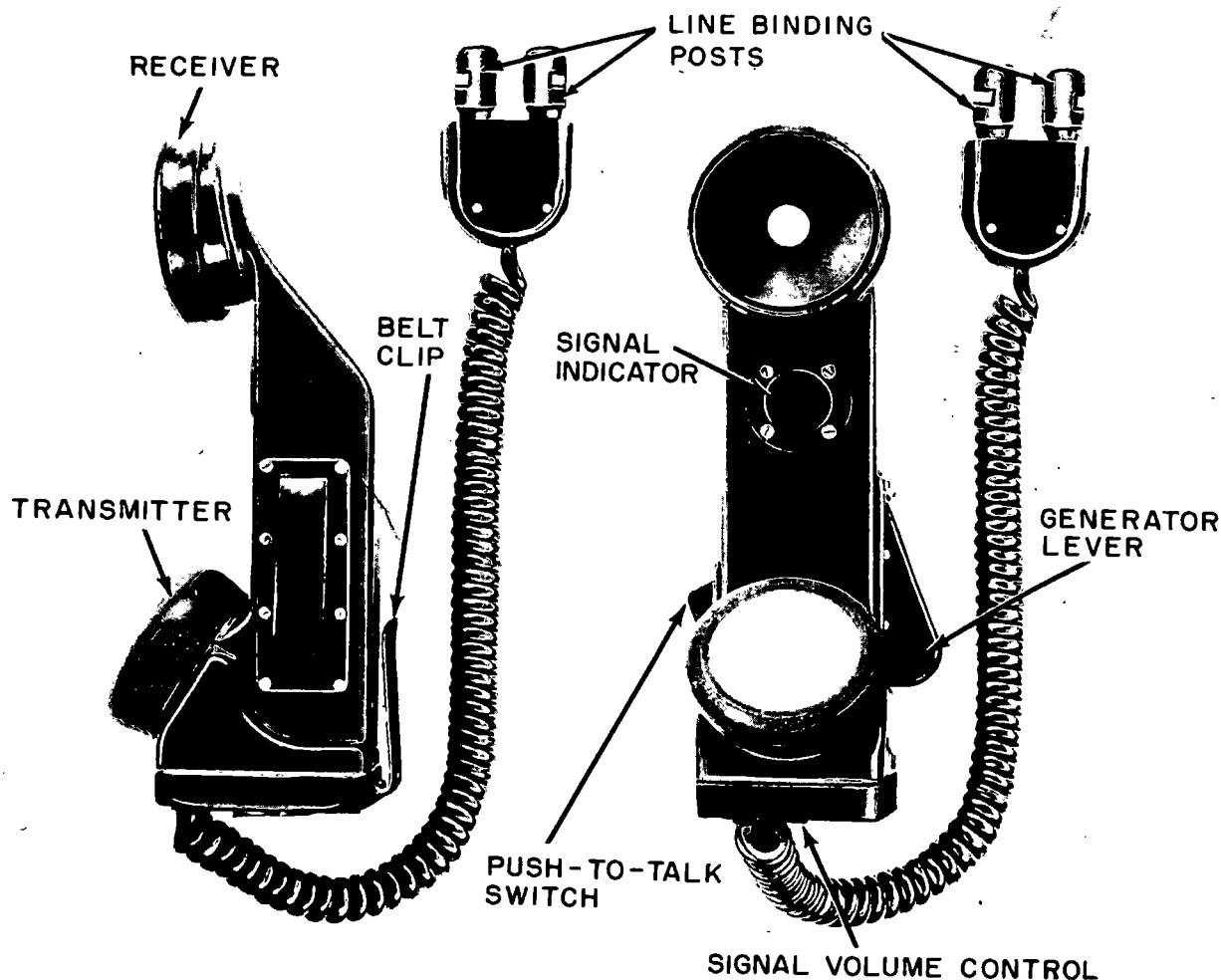


Figure 27. Telephone set TA-1/PT.

WD-1/TT. This telephone set can be used to advantage in forward areas, in switched networks that have magneto signaling switchboards, in closed nets, and in point-to-point circuits.

b. The telephone handset contains sound-powered transmitter and receiver units, a hand generator that is operated by a lever-type switch, and a push-to-talk switch. The user can receive either visual or audible-level signaling indications during operation.

c. The telephone is installed by connecting the wire conductors to the binding posts on the terminal block at the end of the cord.

d. The distance telephone is signaled by depressing and then releasing the generator lever. The audible signal is silenced by turning the switch at the back of the set to OFF. The volume of the audible signal can be controlled by turning

the switch to various settings between OFF and LOUD.

e. The push-to-talk switch is depressed to talk to the distant station. It is possible to hear the distant party faintly if he tries to interrupt while the push-to-talk switch is depressed, but it is necessary to release the switch to hear him clearly.

f. For complete details on the operation and organizational maintenance of and repair parts for telephone set TA-1/PT, refer to TM 11-5805-243-12 and -20P.

138. Telephone Set TA-312/PT

a. Telephone set TA-312/PT (fig. 28) is a local battery (LB) or common-battery (CB) telephone that uses common-battery signaling (CBS).

b. Telephone set TA-312/PT can be used under all outdoor conditions or as a desk or wall-

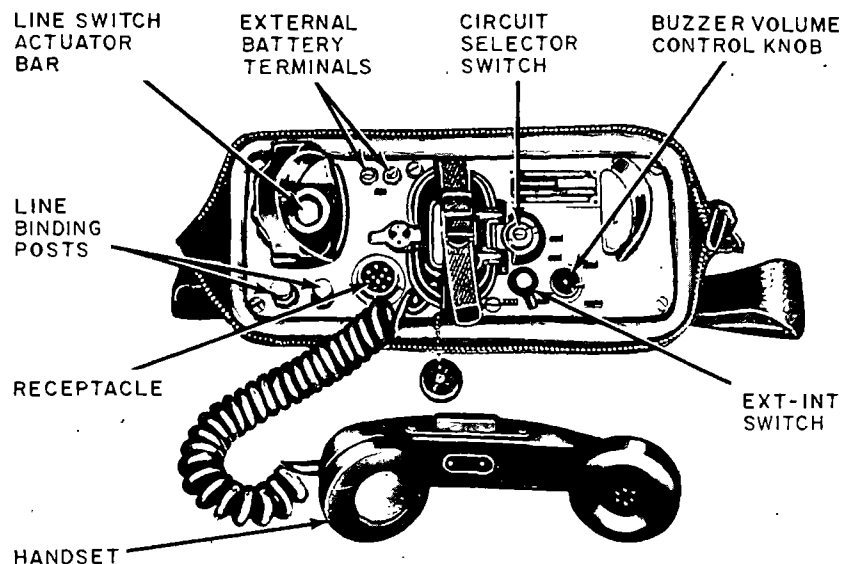


Figure 28. Telephone set TA-312/PT.

mounted telephone. A receptacle is provided for connecting a handset-headset, which may be used in place of the handset provided. In addition, the telephone set can be used to control remotely operated radio equipment.

c. The rated operating range of the TA-312/PT is from 22.5 to 35 kilometers.

d. For complete details on the operation and organizational maintenance of and repair parts for telephone set TA-312/PT, refer to TM 11-2155 and TM 11-5805-201-12.

139. Telephone Set TA-264/PT

a. Telephone set TA-264/PT (fig. 29) is a portable, battery-powered, field-type designed for use on long field cable lines. Vacuum-tube amplifiers in both the transmitting and receiving circuits of the telephone make communication possible over greater distances than is possible with other field telephone sets. When the amplifiers are in use, communication is on a one-way reversible basis. The incoming ringing can be indicated audibly or visually.

b. Telephone set TA-264/PT cannot be used in common-battery systems or over telephone carrier circuits.

c. For further information, refer to TM 11-2059.

140. Manual Telephone Switchboards, General

a. Manual telephone switchboards are designed for use in three types of operation, common-battery, local battery, and common-battery signaling/local-battery operation. Some field switchboards are designed specifically for one type

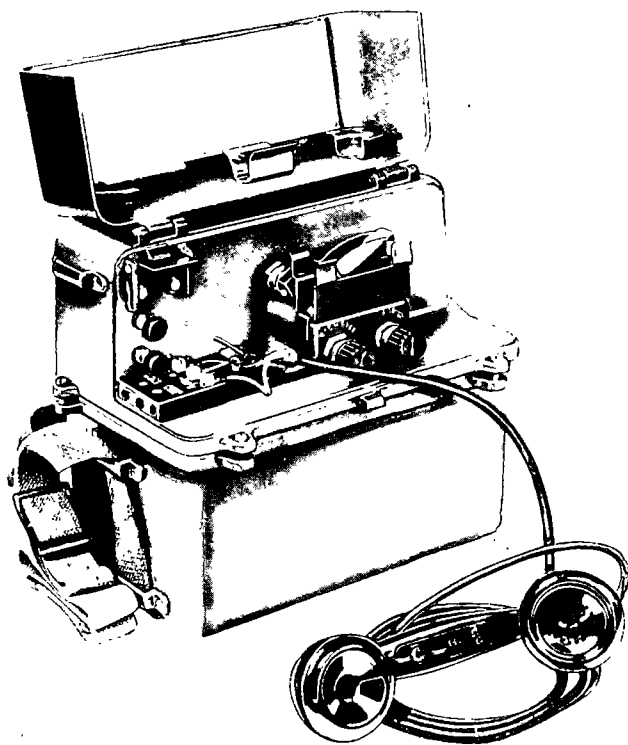


Figure 29. Telephone set TA-264/PT.

of operation. Others are designed for all three types of operation.

b. Field telephone switchboards are manually operated, constructed to withstand rough handling, and designed for quick, simple installation.

c. In a common-battery system, the source of electrical energy for speech and ringing signals is located at the switchboard telephone central. In a local-battery system, the source of electrical energy is located at the telephone set. In a common-battery-signaling/local-battery system, the source of power for speech is located at the telephone set and the power for signaling the switchboard is located at the switchboard.

141. Manual Telephone Switchboard SB-993/GT

a. Manual telephone switchboard SB-993/GT (fig. 30) is a light, portable, local-battery switchboard normally used in company-size units. The switchboard consists of a plug holder and seven 2-pronged adapter plugs U-184/GT in a case. A field telephone is required for the operator's use. The SB-993/GT may be used as an emergency field replacement for any local-battery switchboard.

b. Each adapter plug U-184/GT consists of a neon glow lamp, two binding posts, two plugs, and two jacks, all molded together in a translucent plastic housing. The plugs serve as the thumb-screw ends of binding posts to which incoming lines are connected. The plugs may be inserted into the jacks of another adapter plug U-184/GT to establish a connection between two lines.

c. Several adapter plugs U-184/GT can be connected in tandem for conference connections (several separate parties connected together).

d. An incoming ringing signal lights the neon lamp in the switchboard plug connected to the line for the duration of the signal. There is no audible signal when the neon lamp lights unless the switchboard operator's telephone is connected to that line. The operator must always be alert for an incoming signal.

142. Manual Telephone Switchboards SB-22/PT and SB-22A/PT

a. Manual telephone switchboards SB-22/PT (fig. 31) and SB-22A/PT are lightweight, local-battery, field-type switchboards that provide facilities for interconnecting 12 voice-frequency circuits. The SB-22/PT normally is used to intercon-

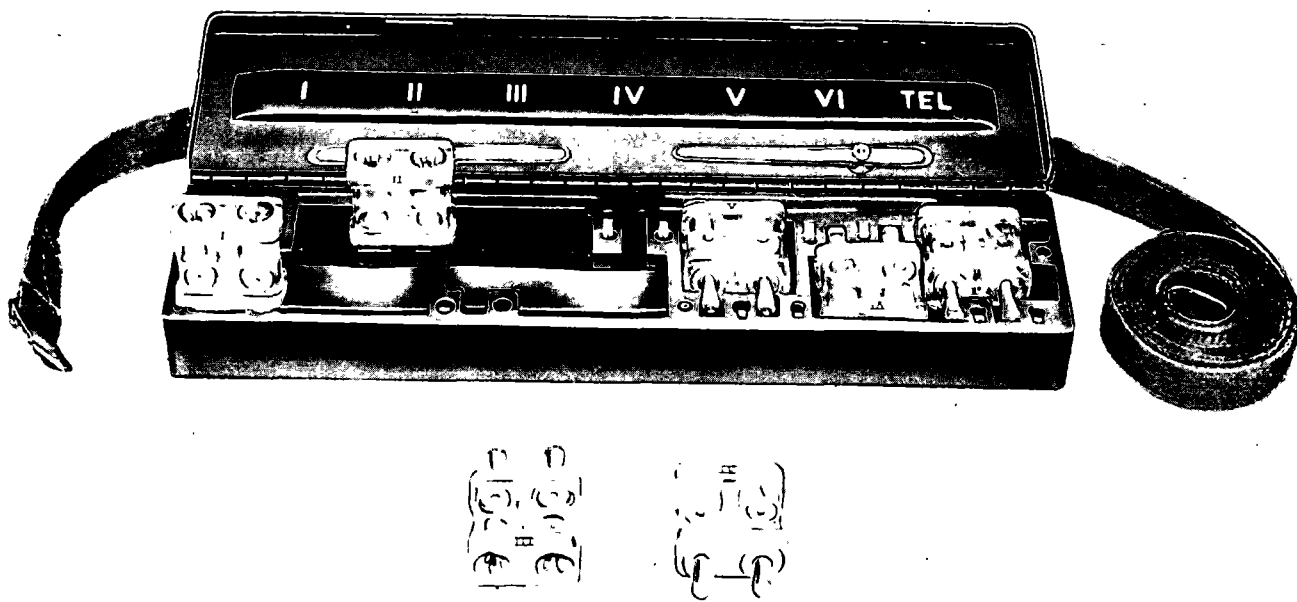


Figure 30. Manual telephone switchboard SB-993/GT.

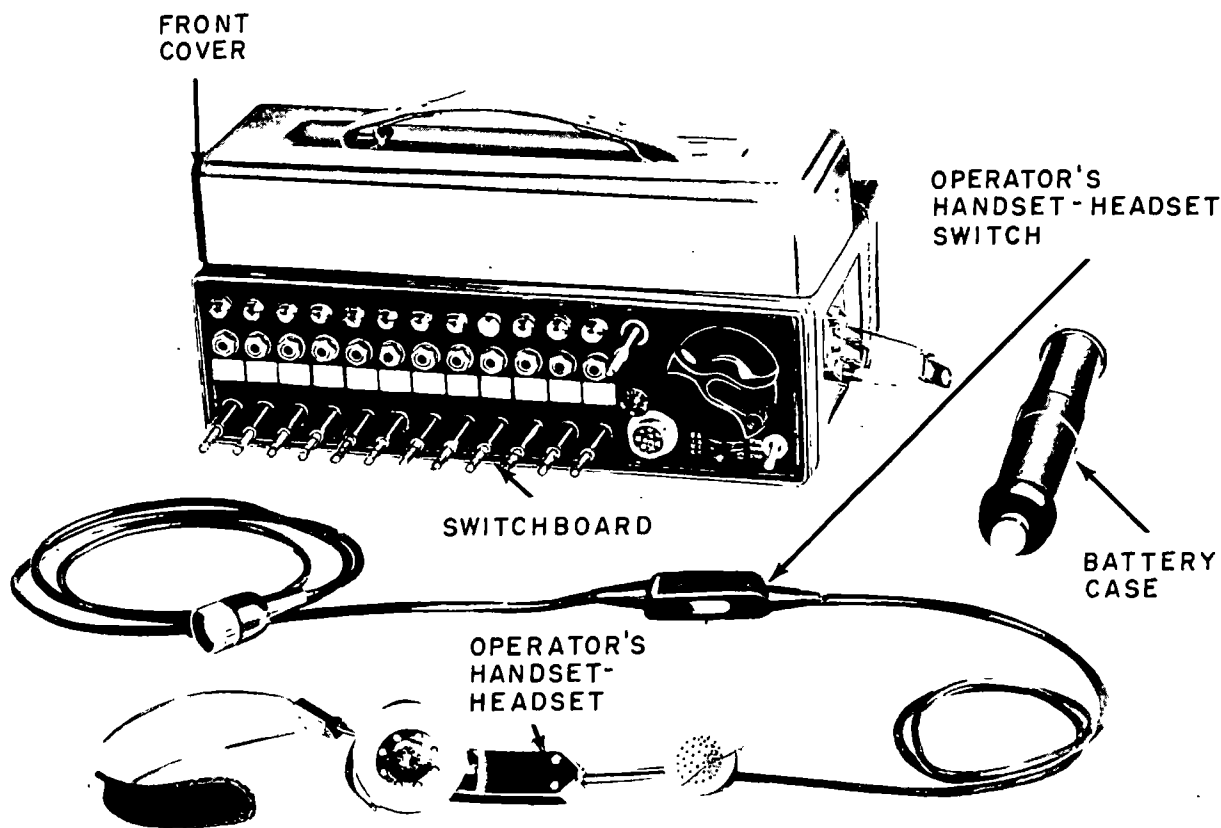


Figure 31. Manual telephone switchboard SB-22/PT.

nect local-battery telephone circuits, remote-controlled radio circuits, and voice-frequency teletypewriter circuits or a combination of these facilities. A capacity of 29 circuits can be obtained by stacking two switchboards and replacing the operator's pack of one switchboard with five additional line jacks.

b. The SB-22/PT obtains operating power for transmitting and night alarm circuits from four batteries BA-30 or from an equivalent DC power source. A hand generator, mounted within the operator's pack, furnishes 20 hertz, 90 to 100 volts for ringing.

c. The SB-22/PT and SB-22A/PT are identical except that in the SB-22A/PT one of the line jacks, furnished in the accessory kit, is replaced by a trunk jack. The trunk jack is used on common-battery-signaling circuits.

d. For complete details on the operation and organizational maintenance of and repair parts for switchboards SB-22/PT and SB-22A/PT, refer to TM's 11-5805-262-12 and -20P.

143. Terminal Telephone Switchboard SB-86/P

a. Terminal telephone switchboard SB-86/P

(fig. 32) is a portable, field-type switchboard used primarily in the field telephone cable system. The component parts of the switchboard can be rapidly assembled or dismantled during tactical employment. Switchboard SB-86/P can be used to interconnect voice-frequency teletypewriter circuits.

b. Terminal telephone switchboard SB-86/P consists of a portable jack field section, switchboard assembly TA-207/P, manual telephone switchboard section SB-248/P, and power supply PP-990/G.

(1) The jack field section has a capacity of 30 complete line circuits. In addition, it contains the line signals, designation strips, panel lamps, and switches necessary for operation of the switchboard. A second jack field section can be stacked on the first to increase the capacity of the switchboard to 60 line circuits (TA-207 ()/P).

(2) The switchboard section consists of eight replaceable cord packs, a cord telephone circuit TA-208/P, and an operator's circuit TA-220/P. Each TA-208/P has two answering and two calling cord circuits, four supervisory signals, and two cord circuit switches.

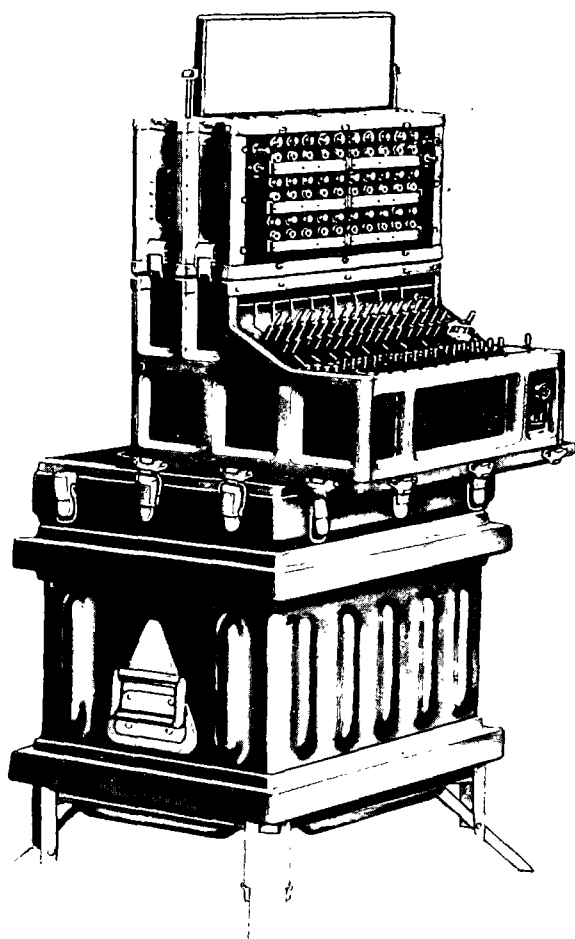


Figure 32. Terminal telephone switchboard SB-86/P.

c. Local-battery or common-battery signaling can be selected by using a switch associated with each line circuit. There are also two common-battery line circuits to be used with common-battery switchboards.

d. The cord circuits of the switchboard do not supply battery power to the distant telephone for speech transmission; therefore, only local-battery telephones or telephones designed for common-battery signaling can be used with this switchboard.

e. For further information, refer to TM 11-2134 and TM 11-5805-303-20P.

144. Terminal Board TM-184

a. Terminal board TM-184 (fig. 33) is a block of insulating material on which are mounted 28 insulation-piercing binding posts and 4 mounting holes. This terminal board can terminate seven pairs of telephone wire.

b. About one-half inch of insulation is removed from the end of the conductor to be connected to the terminal board. The knob on the binding post is unscrewed as far as possible, and the end of the conductor is inserted into the slot so that it projects through binding post.

c. An alternate method is to remove about 1 inch of insulation from the wire. Another 1-inch

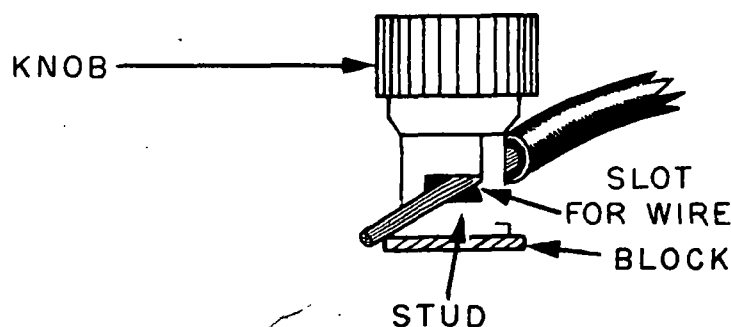
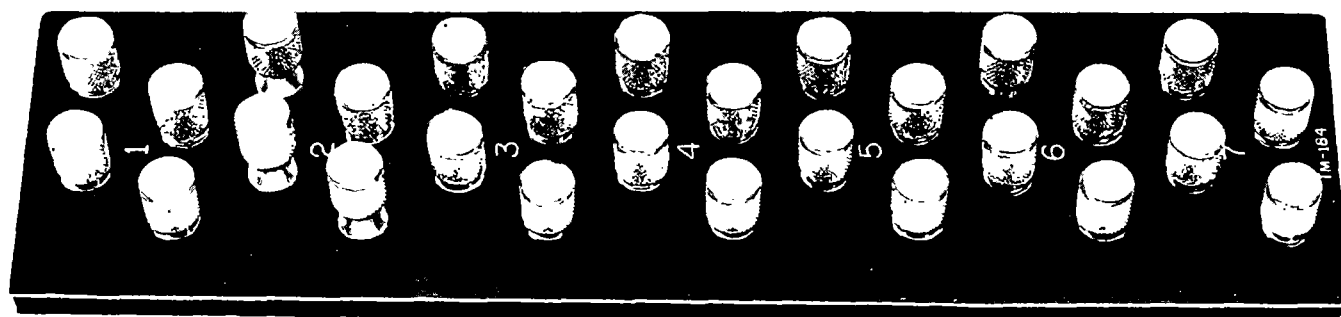


Figure 33. Terminal board TM-184.

strip of insulation is cut and moved to the end of the bared conductor. The bared portion is doubled and inserted into the slot of the binding post. The knob is tightened firmly with the fingers, and the conductors are clamped securely in the slot. Pliers must not be used to tighten or unscrew the knob. Use of pliers could result in stripping the threads on the binding posts.

d. Terminal boards mounted in the open and subjected to the effects of weather must be protected. Since no prescribed cover is provided, covers must be improvised from any suitable material by the installing personnel. Care must be exercised to prevent short circuiting the terminals.

145. Repeating Coils

a. A repeating coil is an audio-frequency transformer (usually with a 1-to-1 winding ratio) which transfers energy from one electrical circuit to another and permits the formation of simplex and phantom circuits for additional teletypewriter or telephone channels. The coil consists of two balanced windings. One winding—the line side—is connected to line terminals. The other winding—the switchboard side—is connected to switchboard terminals. When a telephone is used in place of a switchboard, these windings are connected to the telephone, and the line side of the coil is tapped at midpoint. This tap, called the leg, provides a means for forming simplex and phantom circuits.

b. Telephone repeating coil C-161 (fig. 34) is a ring-through transformer with a 1-to-1 winding ratio. The line-side winding of this transformer is tapped at the center for simplex or phantom circuit operation. The LINE binding posts are connected directly to the line, the SWITCHBOARD binding posts are connected to the line terminals on a switchboard or telephone, and the TELEG binding post is connected to one line terminal of a teletypewriter (except in a phantom circuit, in which case it is connected to the switchboard binding posts of the phantom cable).

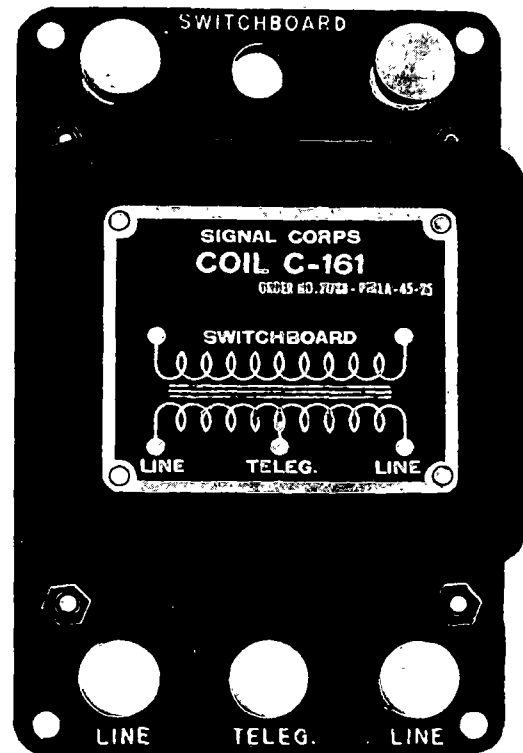


Figure 34. Telephone coil, repeating, C-161.

c. Additional circuits can be obtained from existing metallic circuits with repeating coils. These circuits are as follows:

(1) A simplex circuit is defined as a ground-return telephone or telegraph circuit superimposed on a single metallic circuit to obtain an additional circuit.

(2) A phantom circuit is obtained from two metallic circuits to provide an additional telephone or telegraph circuit.

(3) A simplex-phantom circuit combines the principles of both simplex and phantom circuits to obtain a fourth circuit.

d. For further information concerning repeating coils, refer to TM 11-678.

Section III. TELETYPEWRITER EQUIPMENT

146. Teletypewriter Sets, General

a. A teletypewriter is an electromechanical machine used for the transmission and reception of coded electrical impulses that are converted into a recorded message. Messages are recorded by one of two methods—typed page copy (page-printing teletypewriters) or code perforations on tape (re-

perforators.) Some teletypewriters that record messages by code perforations on tape also record the typewritten characters on the edge of the same tape. Teletypewriter messages are transmitted manually by typing the message on a keyboard or automatically from perforated tape in a transmitter-distributor.

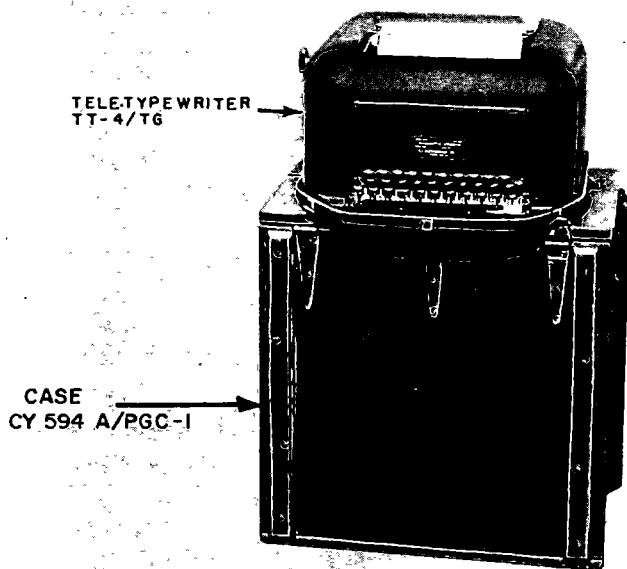


Figure 35. Teletypewriter set AN/PGC-1.

b. The series-governed type motor used in teletypewriter sets require 105-125 volts, dc or 60 Hz ac. Synchronous motors must have 60 Hz alternating current. Direct current must be used for the line signal circuits.

c. Tactical teletypewriter sets are equipped with carrying cases, and necessary accessories, such as recording paper, printing ribbons, and a supply of spare parts.

147. Teletypewriter Set AN/PGC-1

a. Teletypewriter set AN/PGC-1 (fig. 35) is a lightweight, portable, page-printing, sending and receiving set that is designed for field use. It consists of a standard communications teletypewriter (teletypewriter T-4/TG) and case CY-594A/PGC-1.

b. Teletypewriter TT-4/TG is capable of sending and receiving standard teletypewriter

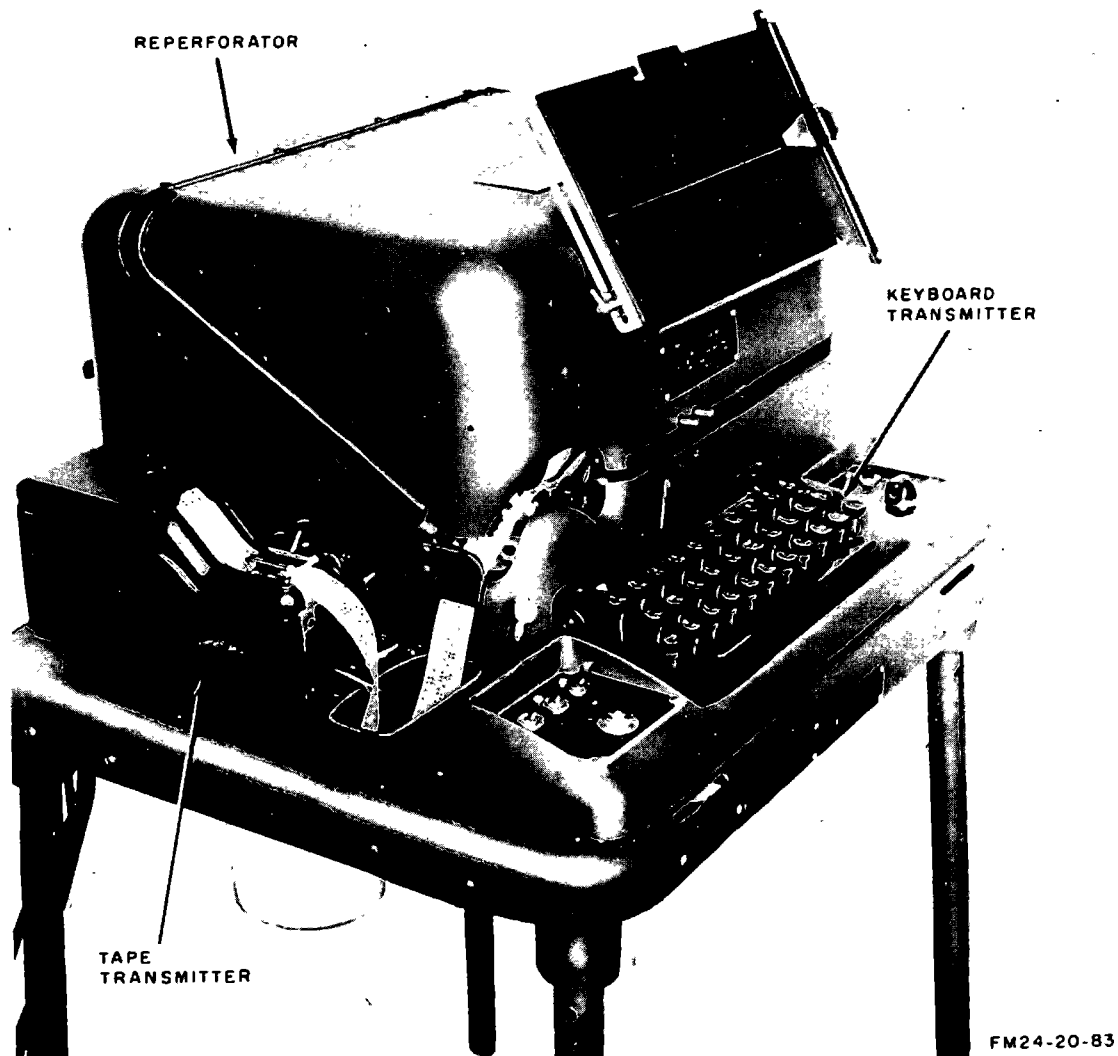


Figure 36. Teletypewriter set AN/GGC-3.

start-stop, five-unit code impulses at speeds of 60, 66, 75, or 100 words per minute, depending on the motor-drive gear set used. It is designed for DC neutral or voice-frequency operation over cable circuits or for DC or voice-frequency operation over telephone carrier systems. The carrier systems may operate over spiral-four cable or radio relay carrier systems. Operation with either 20- or 60-milliampere direct line current is made possible by using a changeover switch.

c. Teletypewriter T-4/TG is not equipped to supply DC power for the line current; this power must be supplied by some external source. A power source of 105- to 125-volt alternating current or direct current is required to operate the teletypewriter.

d. For complete details on the operation and organizational maintenance of and repair parts for this equipment, refer to TM's 11-5815-206-12 and -20P.

148. Teletypewriter Set AN-GGC-3

Teletypewriter set AN/GGC-3 (fig. 36) is a light-

weight, portable, sending and receiving set used in either a tactical or fixed-station military communication system. The transmitted message is sent from either a keyboard or a transmitter-distributor. The received signals are recorded both in code perforations and in typewriter characters on the same tape. Teletypewriter reperforator-transmitter T-76/GGC, the major component of the set, is equipped with a standard communication keyboard and type wheel. Teletypewriter reperforator-transmitter TT-76/GGC can be arranged to operate the neutral and, if modified, polar signals on a half- or full-duplex basis. The selector magnet of this unit can be adapted for 20- or 60-milliampere direct line current. The unit can send and receive standard teletypewriter five-unit, stop-start code impulses at 60, 66, 75, or 100 words per minute, depending on the motor-drive gear that is used. The teletypewriter set is not equipped to supply DC power for the line current. This must be supplied by an external source. A 115- or 230-volt AC power source is required for the motor and rectifier portion of the teletypewriter.

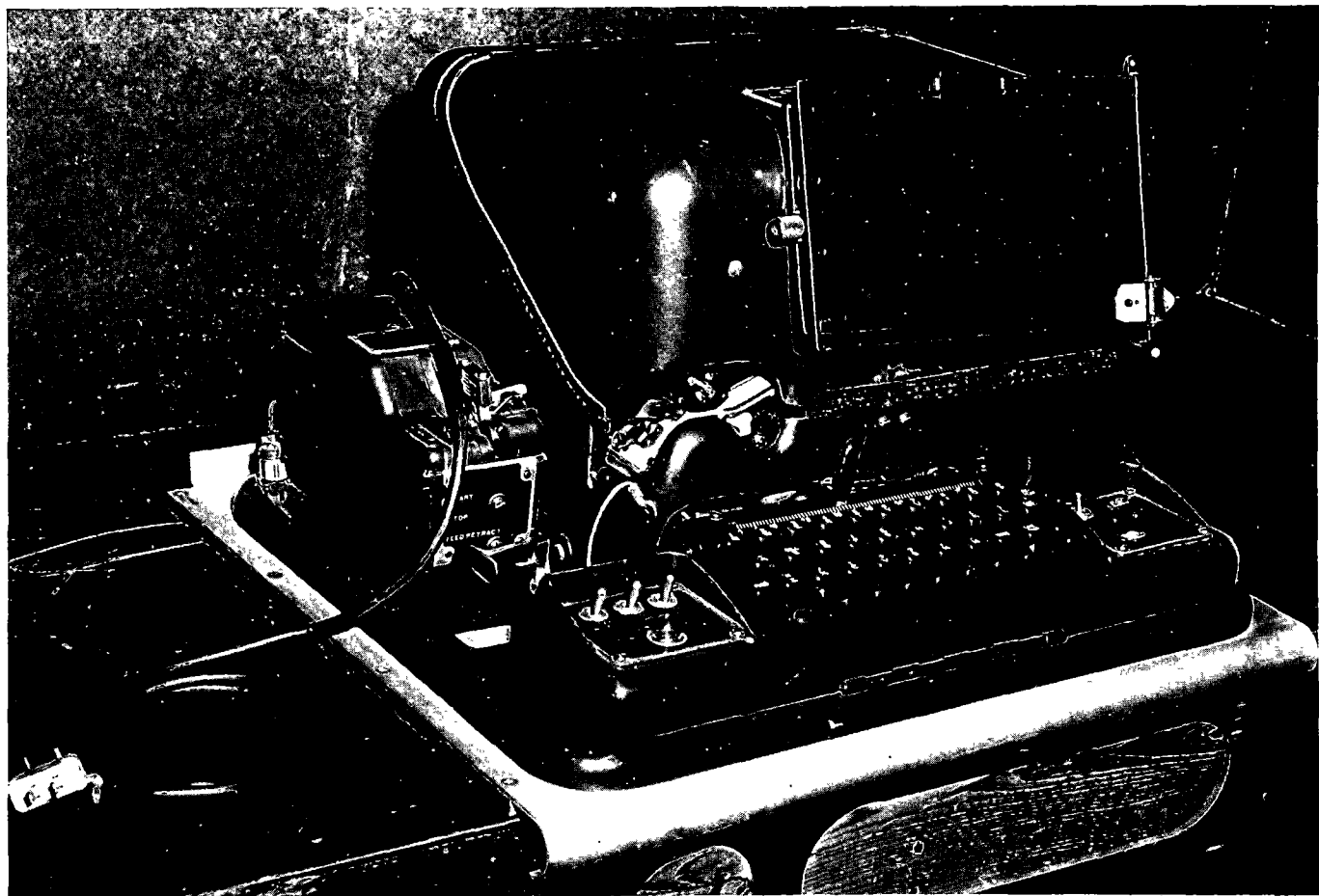


Figure 37. Teletypewriter reperforator-transmitter TT-76/GGC.

149. Teletypewriter Reperforator-Transmitter TT-76()/GGC

a. Teletypewriter reperforator-transmitter TT-76 ()/GG/C (fig. 37) is part of radio teletypewriter sets AN/VRC-29, AN/GRC-46, and AN/GRC-142. The keyboard of this teletypewriter is used to perforate a $\frac{7}{8}$ -inch paper tape and print along the length of the tape a readable copy of the message. The taped message is sent through an automatic tape-sending device, the transmitter-distributor, which is also part of this teletypewriter. As the taped message is transmitted, a printed copy of the message appears simultaneously on typewriter set AN/UGC-4. Controls of the TT-76()/GGC can be arranged to also punch a tape of any received traffic. This tape expedites the relaying of messages.

b. For additional information, see TM 11-5815-238-12.

150. Teletypewriter Set AN/UGC-4

a. *General.* Teletypewriter set AN/UGC-4 (fig. 38) is a page-printing, keyboard-sending teletypewriter designed for use on direct-wire, carrier, or radioteletype circuits. It is part of the equipment of radio teletypewriter sets AN/VRC-29 and AN/GRC-46. It is designed to operate at 60 words per minute; however, it is capable of operating at 66, 75, or 100 words per minute. The operator can type 72 characters per line. A bell signals the operator that he is nearing the end of the line. Page-printed copies (and carbon copies as desired) of all sent and received traffic are obtained.

b. *Use with Radio Teletypewriter Sets.*

(1) Keyboard sending is not often used with radio teletypewriter sets AN/VRC-29 and AN/GRC-46 because these sets have tape-punching and tape-sending equipment. (See para 149.)

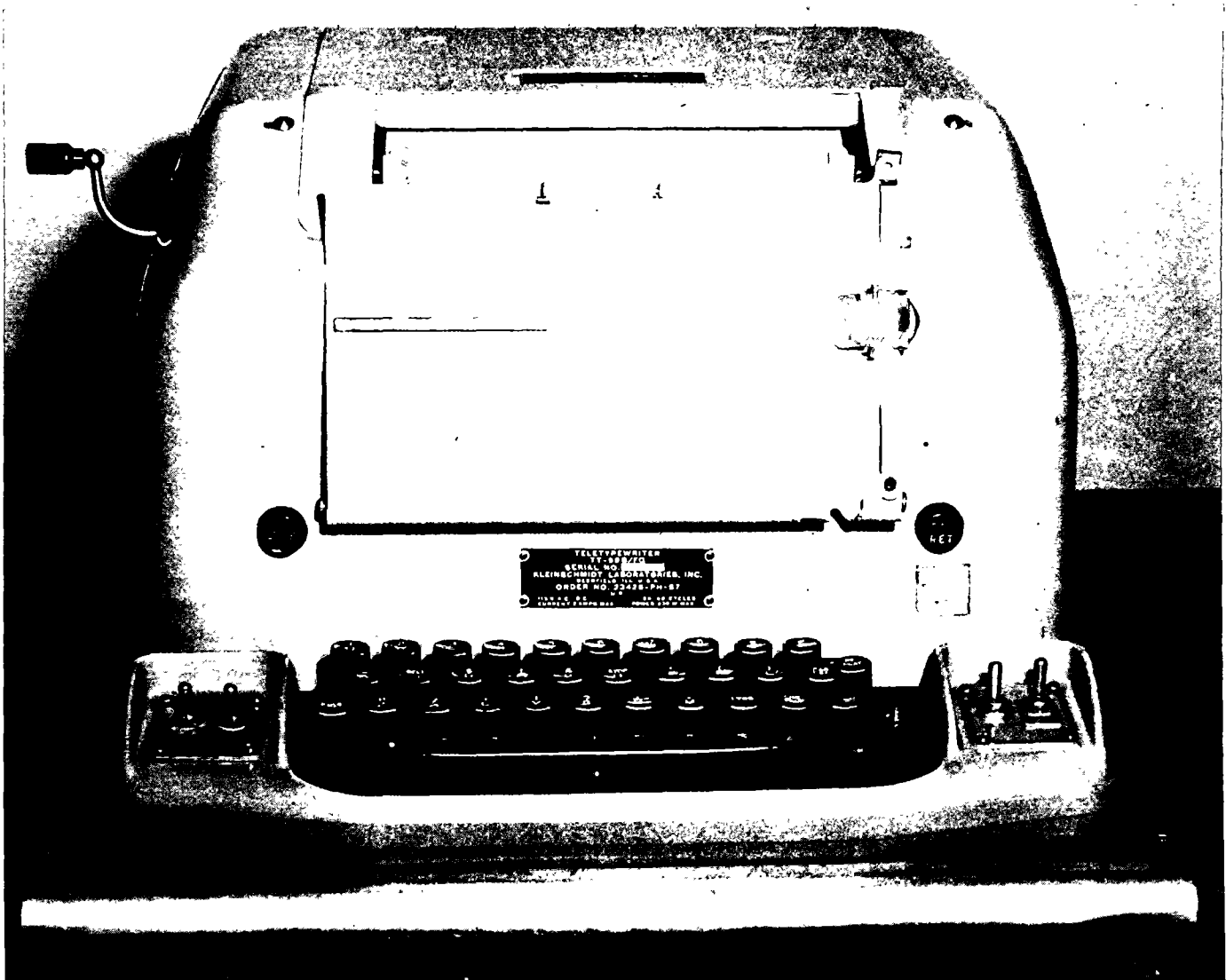


Figure 38. Teletypewriter set AN/UGC-4.

(2) When, as in the case of the AN/VRC-29 and AN/GRC-46, a power supply PP-978/FG is inserted into the chassis of teletypewriter TT-98/FGC, the machine is technically teletypewriter set AN/UGC-4.

c. Reference for additional information see TM 11-5815-200-12.

151. Telegraph Terminal Group AN/TCC-14

a. *General.* Telegraph terminal group AN/TCC-14 is a combination of three separate components—telegraph terminal TH-5/TG (fig. 39), telegraph-telephone signal converter TA-182/U (fig. 40), and electrical filter assembly F-98/U (fig. 41). This combination permits simultaneous

transmission of telegraph pulses and speech. The telegraph signals utilize a portion of the frequency band used by the telephone channel but do not interfere with the use of the channel for speech transmission.

b. *Use.* Telegraph terminal group AN/TCC-14 may be used in conjunction with four different systems. Because of the technical characteristics of the AN/TCC-14, it is advisable that no teletypewriter circuit be superimposed on a common user (switched) telephone circuit. When sole-user voice circuits are available, these circuits should be the first ones considered for speech plus.

(1) *Point-to-point system.* A point-to-point system is a system of communication between two fixed teletypewriter stations.

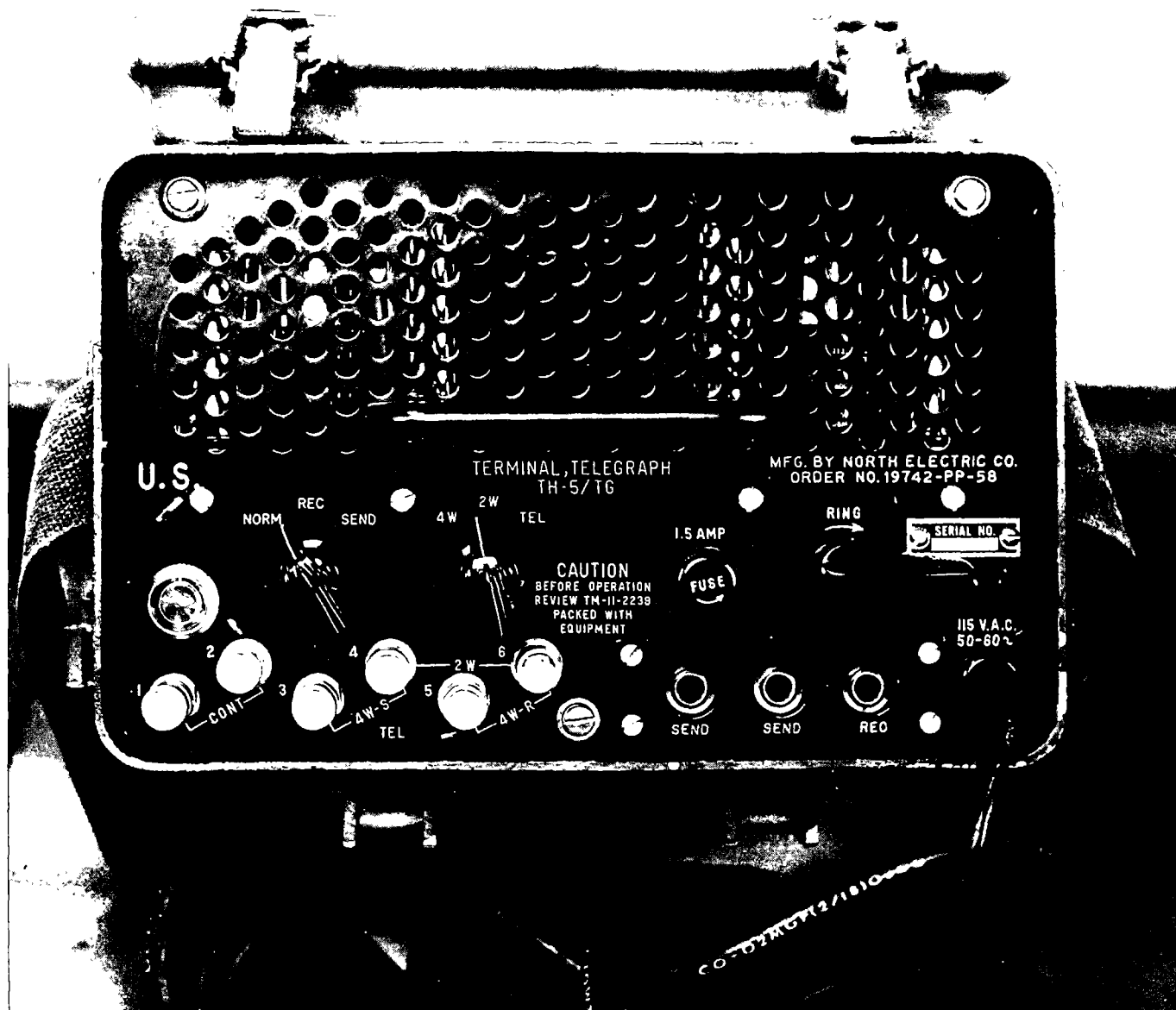


Figure 39. Telegraph terminal TH-5/TG.

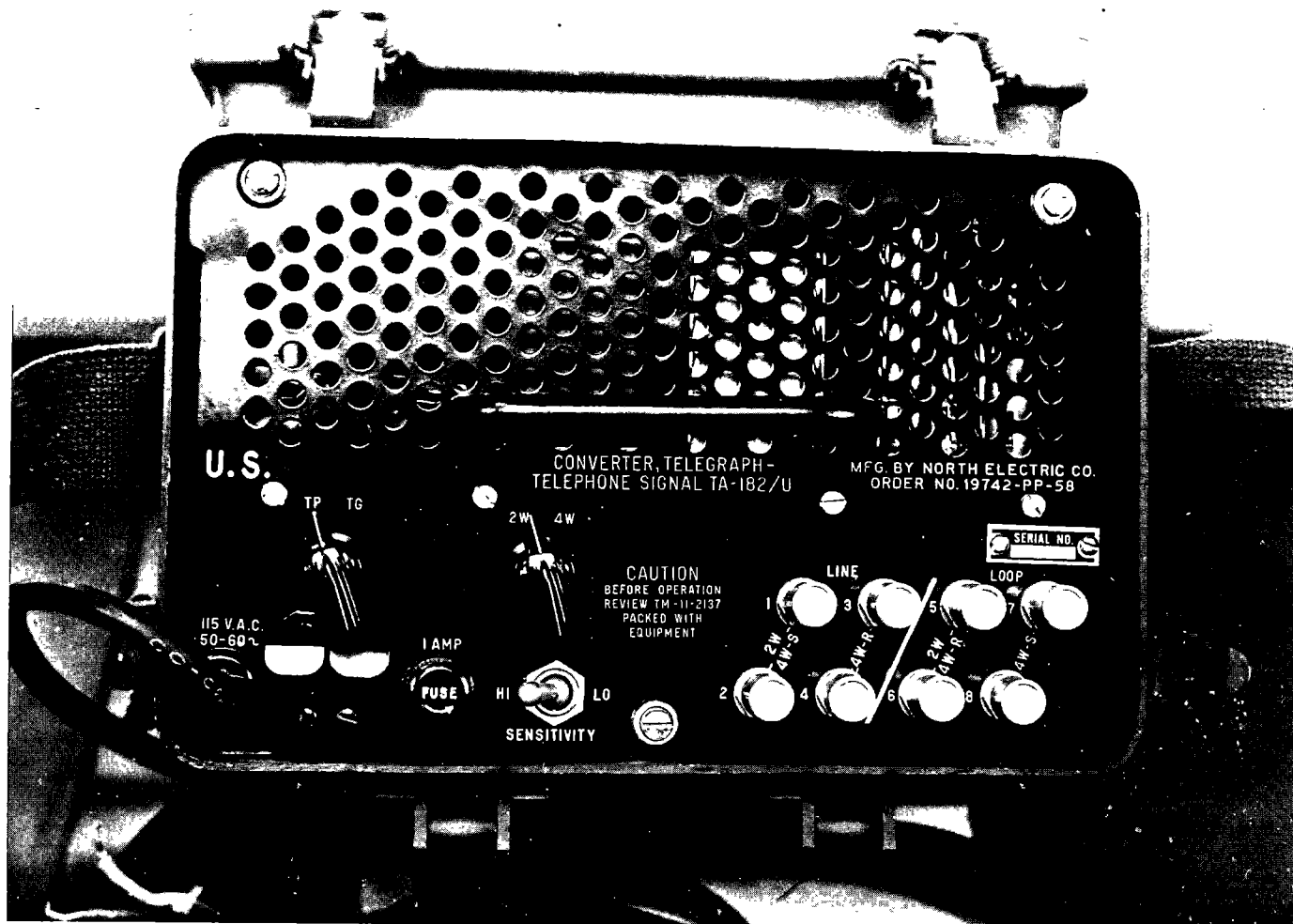


Figure 40. Telegraph-terminal telephone signal converter TA-182/U.

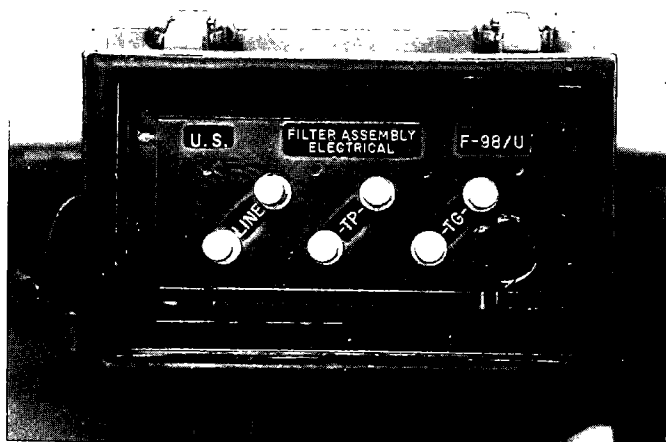


Figure 41. Electrical filter assembly F-98/U.

(2) *Network system.* A network system is a system of communication between three or more teletypewriter stations. In this system, any station may communicate with any other station by using a prearranged code call.

(3) *Switched system.* A switched system is a system of communication between teletypewriter stations that are connected through a switchboard. The station operator makes contact with the switchboard operator, who connects the station with another station.

(4) *Remote control radio system.* A remote control radio system is a system of communication that integrates radio and wire facilities. The remote control device automatically connects a radio transmitter upon receipt of the proper calling signal and automatically disconnects the radio transmitter when the calling signal is removed.

c. Technical Characteristics. The technical characteristics of telegraph terminal group AN/TCC-14 are as follows:

- (1) *Telegraph terminal TH-5/TG.*
 - (a) *Mark frequency:* 1,325 hertz.
 - (b) *Space frequency:* 1,225 hertz.
 - (c) *Type of modulation:* Frequency shift.

(d) *Bandwidth*: 200 hertz.

(e) *Transmission speeds*: 60, 75, and 100 words per minute (wpm).

(f) *Receiving direct current*: 20 milliamperes (ma) (min).

(g) *Power drain*: 60 watts.

(h) *Power source requirement*: 115 volts, 60 hertz.

(2) *Telegraph-telephone signal converter TA-182/U*.

(a) *Frequency of telegraph signaling*: 1,225 hertz.

(b) *Frequency of telephone signaling*: 1,600 hertz.

(c) *Low-frequency signal input*: 20 hertz.

(d) *Power drain AC source*: 40 watts.

(e) *Power source requirements*: 115 volts, 60 hertz.

(3) *Electrical filter assembly F-98/U*.

(a) *Midfrequency operation*: 1,275 hertz.

(b) *Bandwidth*: From 100 to 200 hertz.

(c) *Supervisory signal*: 20 hertz at 100 ma.

d. Description of Components.

(1) Telegraph terminal TH-5/TG is a 15-tube, frequency-shift-carrier modulator and demodulator. It modulates DC teletypewriter pulses to 1,225-hertz and 1,325-hertz frequencies. It demodulates 1,225-hertz and 1,325-hertz frequencies to DC teletypewriter pulses. These DC pulses must be capable of activating a teletypewriter selector magnet, which requires a 20-milliamperere current. The TH-5/TG is a compact, lightweight unit of miniature construction. The panel contains two 3-position wafer-type switches, which are used to select the type of operation; a nonlocking lever switch, which is used to transmit the 20-hertz frequency; three jacks for teletypewriter connections; and six binding posts for connections in two-wire, four-wire, and radiotelegraph application. Operation using the TH-5/TG is known generally as one-way reversible; that is, only one TH-5/TG may transmit at a time. If two TH-5/TG's transmitted at the same time, the transmitted signal in each case would blank out the received signal; therefore, a break-in would not be possible. However, a 20-hertz ringing signal can be transmitted by the receiving station to the transmitting station when break-in is desired.

(2) Telegraph-telephone signal converter TA-182/U provides a means of signaling in circuits which will not pass 20-hertz ringing signals because of line or equipment characteristics. It is

an eight-tube, frequency-shift-carrier modulator and demodulator. It modulates 20-hertz frequencies to either 1,225-hertz frequencies for teletypewriter signaling or to 1,600-hertz frequencies for telephone signaling. It demodulates both the 1,225-hertz and 1,600-hertz frequencies to 20-hertz frequencies to activate the signaling device on a switchboard or telephone. The panel contains two 2-position wafer-type switches, which are used to select the specific type of operation. A toggle-switch is used to adjust the sensitivity of the TA-182/U receiving circuit. Eight binding posts are used for line and loop connections.

(3) Electrical filter assembly F-98/U is a two-section filter. The band-pass section is used for teletypewriter transmission. The band-stop section is used for telephone transmission. Use of the F-98/U permits simultaneous teletypewriter and telephone service; the band-pass and band-stop sections of the F-98/U separate the teletypewriter and telephone signals. The F-98/U is hermetically sealed, requires no adjustment, and has no controls or indicators. The six binding posts located on the face of the panel are for interconnection with the associated equipment and the line.

e. Installation. Normally, the AN/TCC-14 is installed near the equipment to which it is connected. Prior to installation, the components are mounted in racks or stacked at the equipment site. Figure 42 shows a typical application of the AN/TCC-14. For detailed information on other applications, refer to TM 11-5805-254-15.

152. Telegraph-Telephone Terminal AN/TCC-29

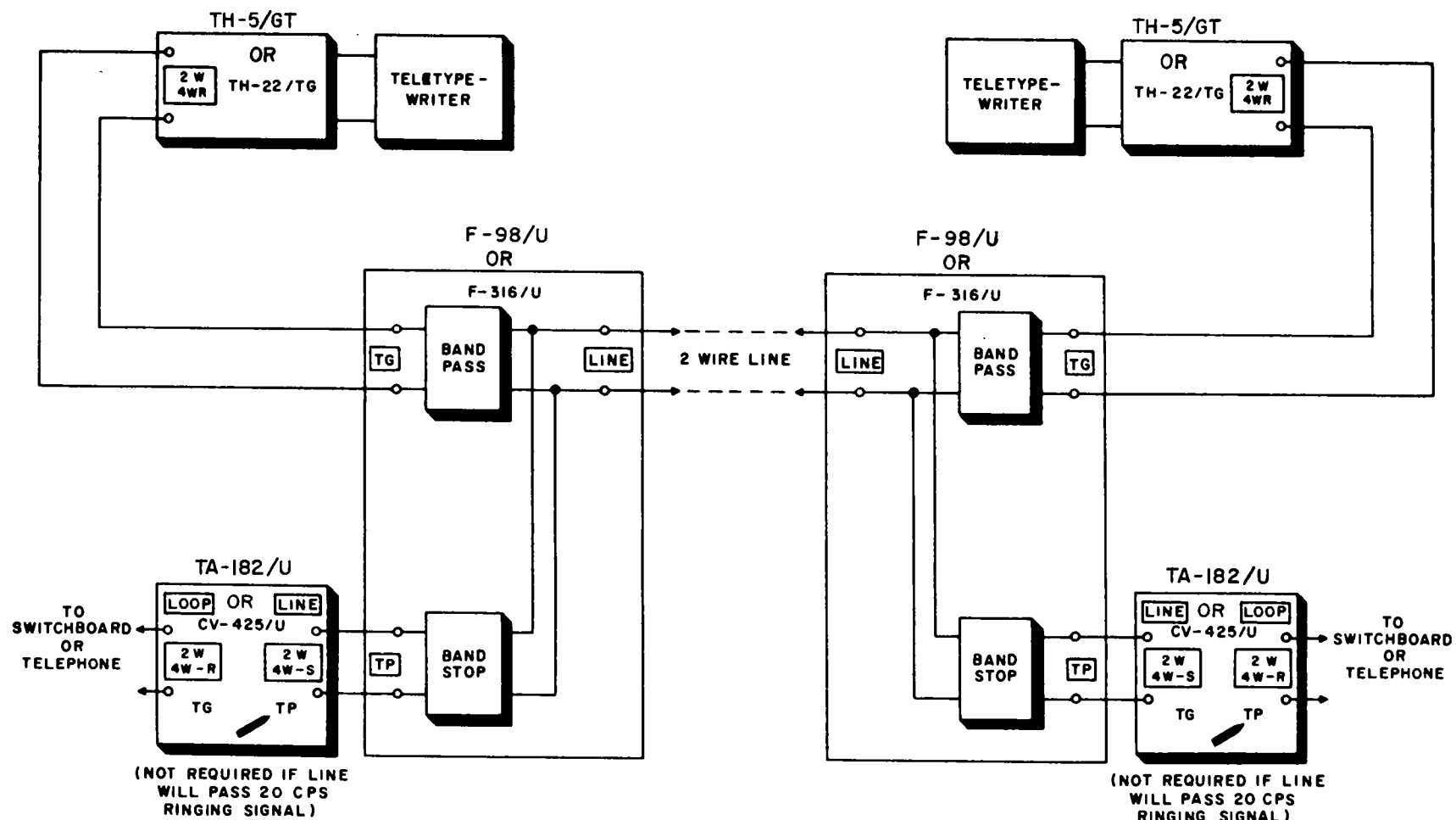
a. Telegraph-telephone terminal AN/TCC-29 is a transistorized assemblage which will replace the AN/TCC-14. The components of both equipments are interchangeable and fully compatible. Telegraph-telephone terminal AN/TCC-29 permits simultaneous transmission of speech and teletype signals over a single voice-frequency circuit. The AN/TCC-29 is used to provide speech plus half-duplex service in point-to-point, network, switched, or remote control radio systems. Major components of the AN/TCC-29 are—

(1) Telegraph terminal TH-22/TG.

(2) Electrical filter assembly F-316/U.

(3) Telegraph-telephone signal converter CV-425/U.

b. For more details, see paragraph 153 and TM 11-5805-356-12.



TM 5805-356-12-10

Figure 42. Typical application of telegraph terminal group AN/TCC-14 or AN/TCC-29.

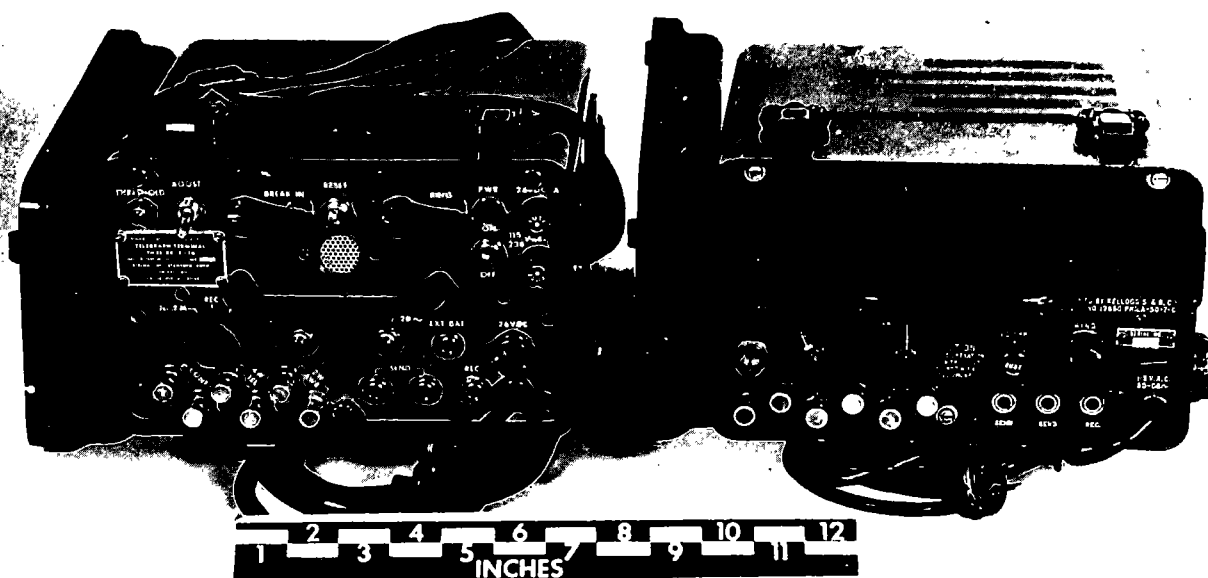


Figure 43. Telegraph terminals TH-22/TG and TH-5/TG.

153. Technical Characteristics of AN/TCC-29

a. *Telegraph Terminal TH-22/TG.* Telegraph terminal TH-22/TG is a transistorized frequency shift modulator and demodulator. During transmission, it modulates direct current teletypewriter pulses (mark and space) to 1,317.5 hertz and

1,232.5 hertz, respectively. During teletypewriter receiving operations, it demodulates these frequencies to direct current pulses. It also provides break-in (1,180 hertz) signaling during teletype reception—20 hertz and voice frequency signaling (1,232.5 hertz)—and remote control keying of

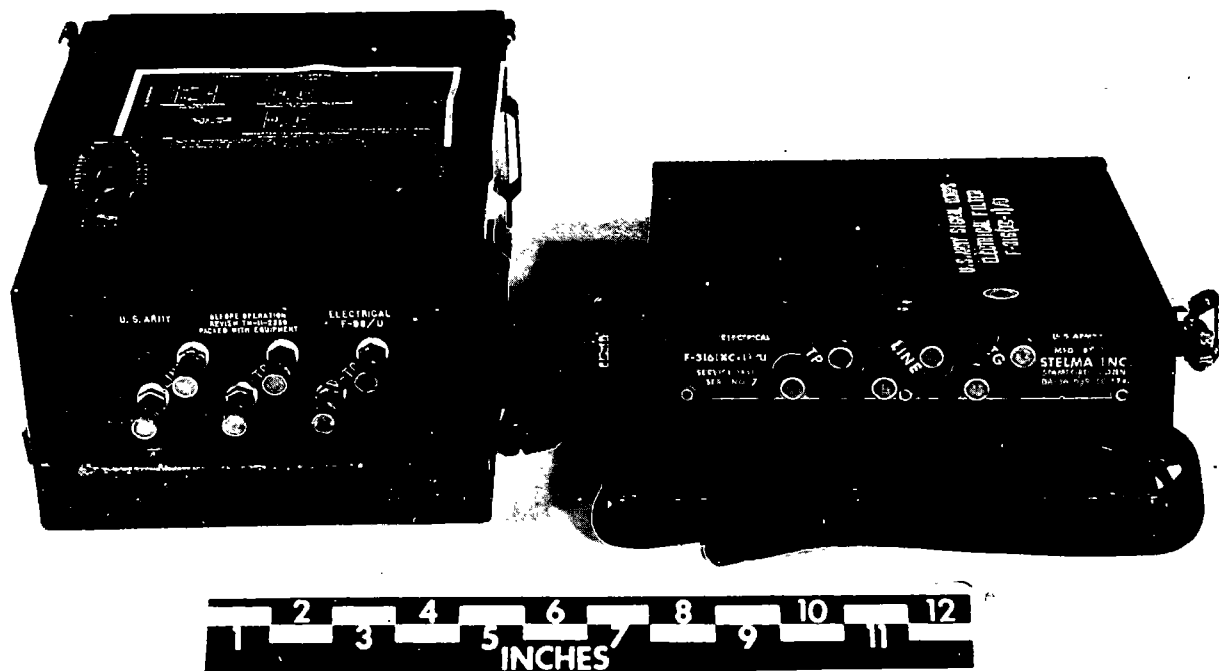


Figure 44. Electrical filter assemblies F-98/U and F-316/U.

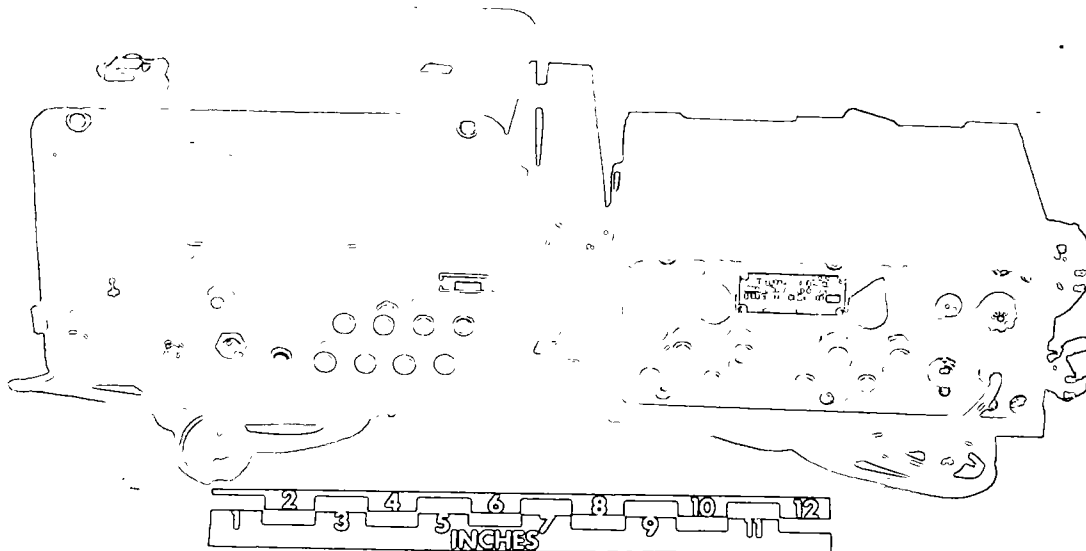


Figure 45. Telegraph-telephone signal converters TA-182/U and GV-425/U.

radio equipment. The TH-22 operates from a 115/230-volt, 50- to 60-hertz AC or 24-volt DC power source. This component is essentially the transistorized counterpart of the old telegraph terminal TH-5/TG (see fig. 43).

b. *Electrical Filter Assembly F-316/U.* Electrical filter assembly F-316/U is a hermetically sealed two-section filter designed to separate the teletype transmission frequencies from the telephone transmissions frequencies. A band-pass section of 1,100 to 1,400 hertz is used for teletypewriter transmission. The remaining portion of the 300- to 3,500-hertz voice band is used for telephone transmission. Use of this filter assembly permits simultaneous teletypewriter and telephone

transmissions. This component requires no power source and is essentially the lightweight counterpart of the old filter assembly F-98/U (see fig. 44).

c. *Telegraph-Telephone Signal Converter CV-425/U.* Telegraph-telephone signal converter CV-425/U provides the capability of voice-frequency signaling. It converts 20 hertz loop signaling frequencies to 1,232.5 hertz for teletypewriter line signaling and to 1,600 hertz for telephone line signaling. A power source of 115/230 volts alternating current is required for this item. This component is essentially the transistorized counterpart of the old telegraph-telephone signal converter TA-182/U (see fig. 45).

Section IV. RADIO EQUIPMENT

154. General

This section contains general information concerning the characteristics of the major items of radio equipment used by field artillery units. For operating instructions and detailed information pertaining to this equipment, see the appropriate 11-series of technical manuals. For type radio nets, see chapter 20. For detailed information on field radio techniques, see FM 24-18.

155. Radio Receiving Set AN/GRR-5

a. *General.* Radio receiving set AN/GRR-5 (fig. 46) is an amplitude modulated receiver which may be operated in a field, vehicular, or fixed installa-

tion. It consists of receiver R-174/URR and power supply PP-308/URR, plus necessary cables and accessories required for operation.

b. *Type of Reception.* The AN/GRR-5 will receive continuous wave (CW), modulated continuous wave (MCW), or voice signals.

c. *Frequencies.* The overall frequency coverage of the AN/GRR-5 ranges from 1.5 to 18.0 megahertz in four bands.

d. *Method of Calibration.* The receiver is equipped with a built-in crystal frequency oscillator for calibration, with calibration check points every 200 kilohertz, beginning at 1.6 megahertz.



Figure 46. Radio receiving set AN/GRR-5.

e. Presets. The AN/GRR-5 features continuous tuning throughout its frequency range, with facilities available for mechanically presetting 10 channels.

f. Antenna. A four-section mast antenna or any suitable long-wire antenna may be used.

g. Power. The power input for the AN/GRR-5 may be furnished by any one of the following sources:

- (1) Dry batteries (two BA-419 and one BA-405).
- (2) Storage batteries (6-, 12-, or 24-volt).
- (3) Commercial power (115-volt alternating current).

h. Reference. For complete details on the operation and maintenance of the AN/GRR-5, refer to TM 11-295.

156. Radio Set AN/GRC-19

a. General. Radio set AN/GRC-19 (fig. 47) is a medium-power, amplitude modulated radio used for transmitting and receiving voice and radio-telegraph (CW) signals.

b. Range. The reliable operating range of radio set AN/GRC-19 is from 30 to 80 kilometers for voice operation, 120 kilometers for CW, and 240 to 2400 kilometers for skywave operation.

c. Frequencies. The frequencies of the trans-

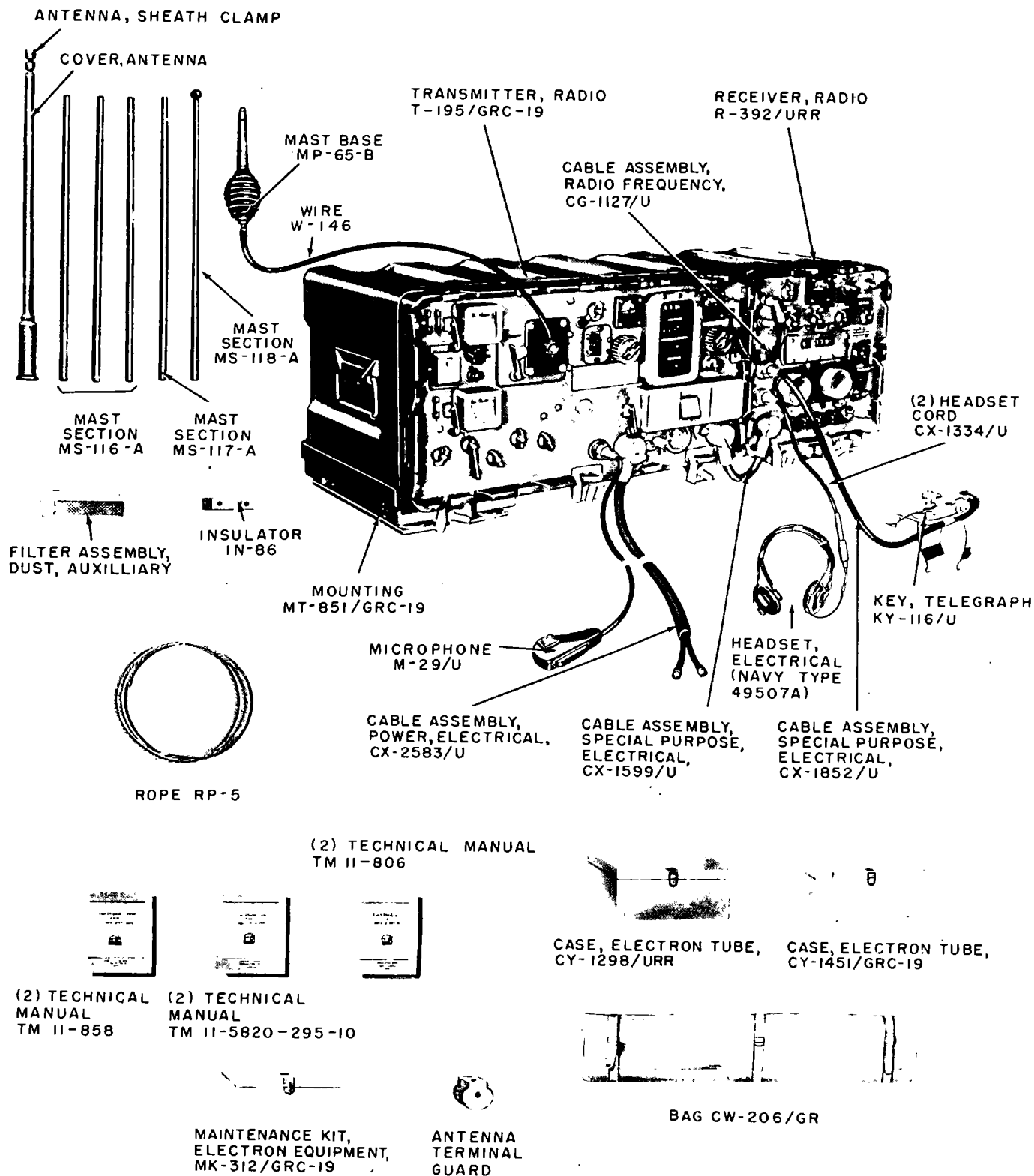


Figure 47. Radio set AN/GRC-19.

mitter and receiver of the AN/GRC-19 are as follows:

(1) *Transmitter*: From 1.5 to 20.0 megahertz in 10 bands.

(2) *Receiver*: From 0.5 to 32.0 megahertz in 32 bands.

d. *Presets*. The transmitter operating frequency can be selected by one manual preset or automati-

cally by any one of the other seven preset channels. There are no preset channels on the receiver.

e. Power Input. Input voltage is from 22 to 30 volts direct current.

f. Antenna. Radio set AN/GRC-19 is equipped with a 15-foot whip antenna. Antenna groups AN/GRA-12 and AN/GRA-50 may be used, although this equipment is not a component of the radio set.

g. Type of Installation. The AN/GRC-19 is designed for a mobile or semifixed installation.

h. Remote Control. Remote control of the transmitter (from distances up to 75 feet) is possible when the transmitter is used with transmitter control C-822/GRC-19 and a special purpose cable. The remote control unit turns the transmitter on and off and selects the type of service and the preset channels from the remote control position.

i. Other Component Parts. Other component parts of the AN/GRC-19 are as follows:

(1) Necessary antenna installation equipment.

(2) Telegraph key, microphones, headsets, and spare parts.

j. References. For complete details concerning the operation, organizational maintenance, and repair parts, refer to TM's 11-5820-295-10, -20, and -20P.

157. Radio Teletypewriter Set AN/GRC-46

a. Radio teletypewriter set AN/GRC-46 (fig. 48) consists of assemblies of transmitting, receiving, and teletypewriter equipment arranged in a shelter and mounted on a vehicle. The AN/GRC-46 can provide either separate or simultaneous transmissions or receptions of voice and radio-teletype signals. In addition to the same trans-

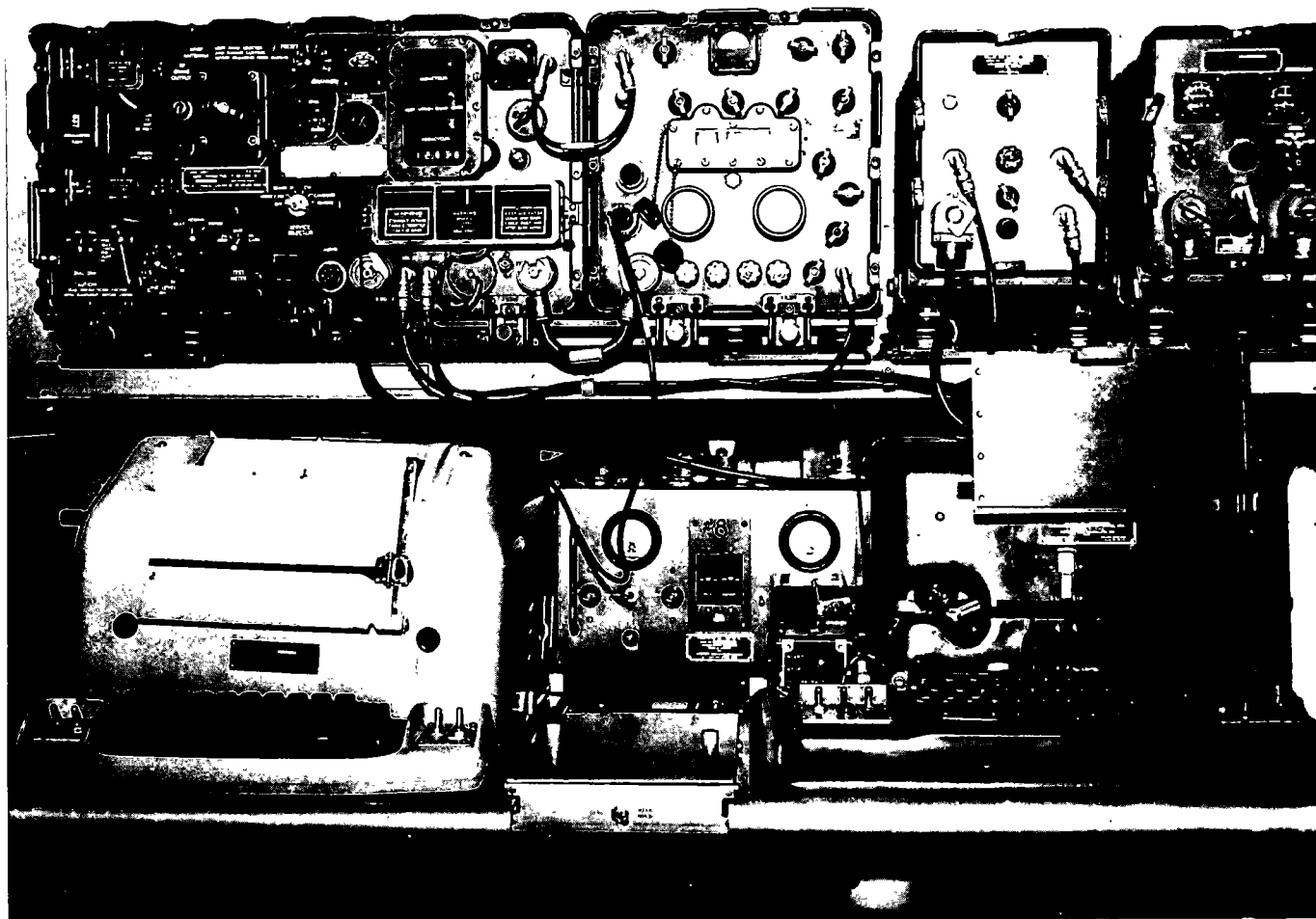


Figure 48. Radio teletypewriter set AN/GRC-46.

mitter and receiver used by the AN/GRC-19 radio, the AN/GRC-46 is equipped with a modulator, a frequency-shift converter, a teletypewriter reperforator, a teletypewriter page printer, and an interconnecting box. All of the components are mounted in a shelter equipped with electric lights, a heater, a ventilation system, and blackout blinds. Although designed primarily for use in a $\frac{3}{4}$ -ton truck, the radio may be installed in any vehicle that is large enough to accommodate the shelter and which has a suitable electrical power system.

b. Technical characteristics are as follows:

(1) *Type of installation:* Vehicular (shelter on $\frac{3}{4}$ -ton truck).

(2) *Type of modulation:* Amplitude modulated.

(3) *Type of emission:* Voice, continuous wave (CW), frequency-shift-keyed (FSK) (RATT), or voice and FSK simultaneously.

(4) *Frequency range:*

(a) *Transmitter:* From 1.5 to 20.0 megahertz.

(b) *Receiver:* From 0.5 to 32.0 megahertz.

(5) *Transmission planning range (with whip antenna):*

(a) *Voice/FSK:* 80 kilometers (50 miles).

(b) *CW:* 80 kilometers (50 miles).

(6) *Power output (nominal):* 100 watts.

(7) *Power source:* From 22 to 30 volts direct current.

(8) *Antenna:*

(a) Whip, 15 feet long (three MS-116, one MS-117, one MS-118).

(b) Doublet.

(9) *Teletypewriter speed (automatic):* 60 words per minute.

c. For detailed information concerning the operation, organizational maintenance, and repair parts, refer to TM's 11-5815-204-10, -20, and -20P.

158. Radio Set AN/VRC-24

a. Radio set AN/VRC-24 (fig. 49) is a VHF-UHF, amplitude modulated, voice communication radio used for vehicular ground-to-air communication. It may also be used as a retransmission device for one of the FM radio sets.

b. Technical characteristics of radio set AN/VRC-24 are as follows:

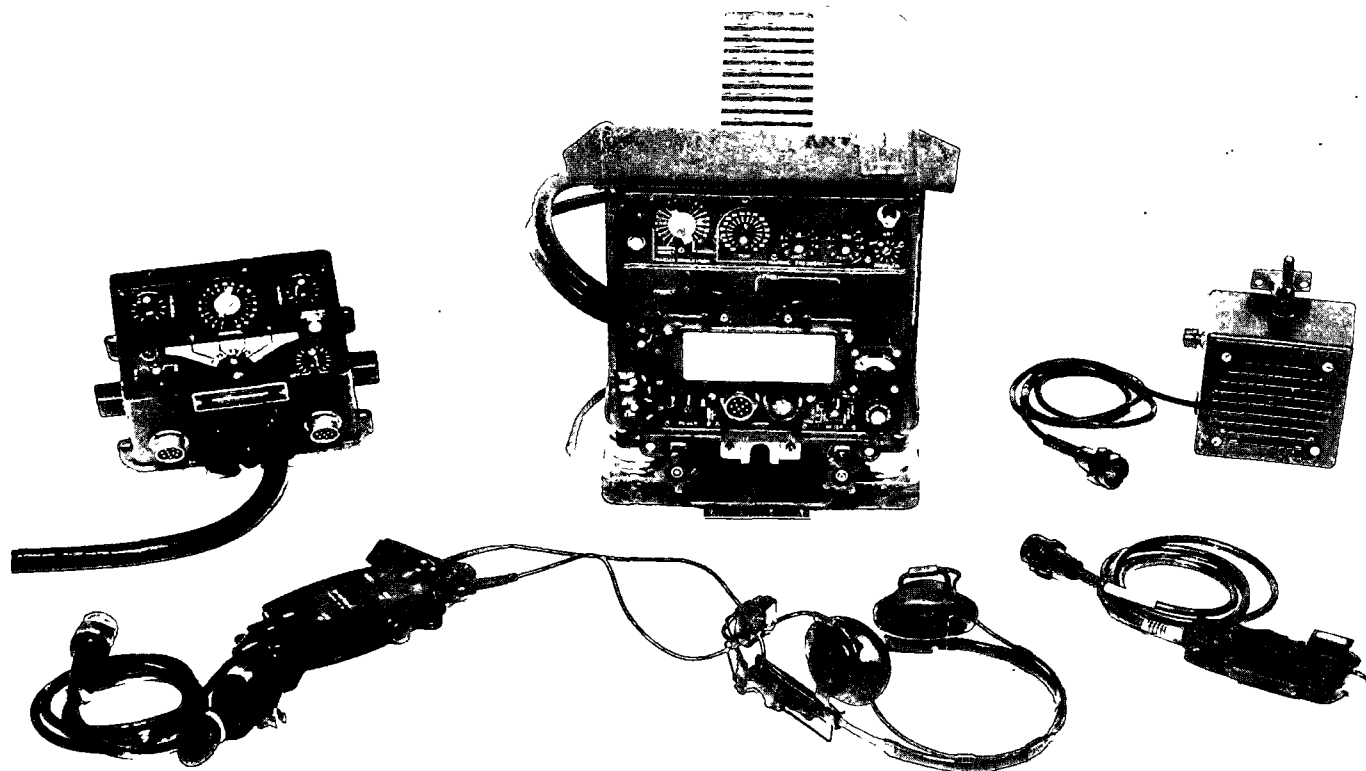


Figure 49. Radio set AN/VRC-24.

(1) *Frequency range*: From 225.0 to 399.9 megahertz.

(2) *Communication channels*: 1,750.

(3) *Preset channels*: 20.

(4) *Power source*: 24 volts direct current.

(5) *Operating range*: Depends on the line of sight and on the altitude of the aircraft. (About 48 kilometers at 1000 feet; about 160 kilometers at 10,000 feet.)

(6) *Antenna*: A 10-inch vehicular antenna is provided with the set.

(7) *Type of modulation*: Amplitude.

(8) *Operation*: Local or remote.

c. For information concerning the operation, organizational maintenance, and repair parts, refer to TM's 11-5820-222-10, -20, and -35.

159. Radio Sets AN/PRC-8, -9, and -10

a. *General*. Radio sets AN/PRC-8, -9, and -10 (fig. 50) are issued to armor, artillery, and infantry units, respectively as long as this series of radios is used. Artillery units supporting armor or infantry are also issued radio sets of the armor or infantry series. These radio sets are versatile, since they may be operated from a pack, ground, aircraft, or vehicular installation. The sets are basically identical. Internally, they differ in the equipment which determines the frequency of the radio signals transmitted and received; externally, they differ in the calibration of the tuning dial. (For individual frequency ranges, see d(3) below.)

b. *Frequency Overlap*. A 1-megahertz overlap in frequency coverage between radio sets AN/PRC-8 and AN/PRC-9 provides 10 channels for

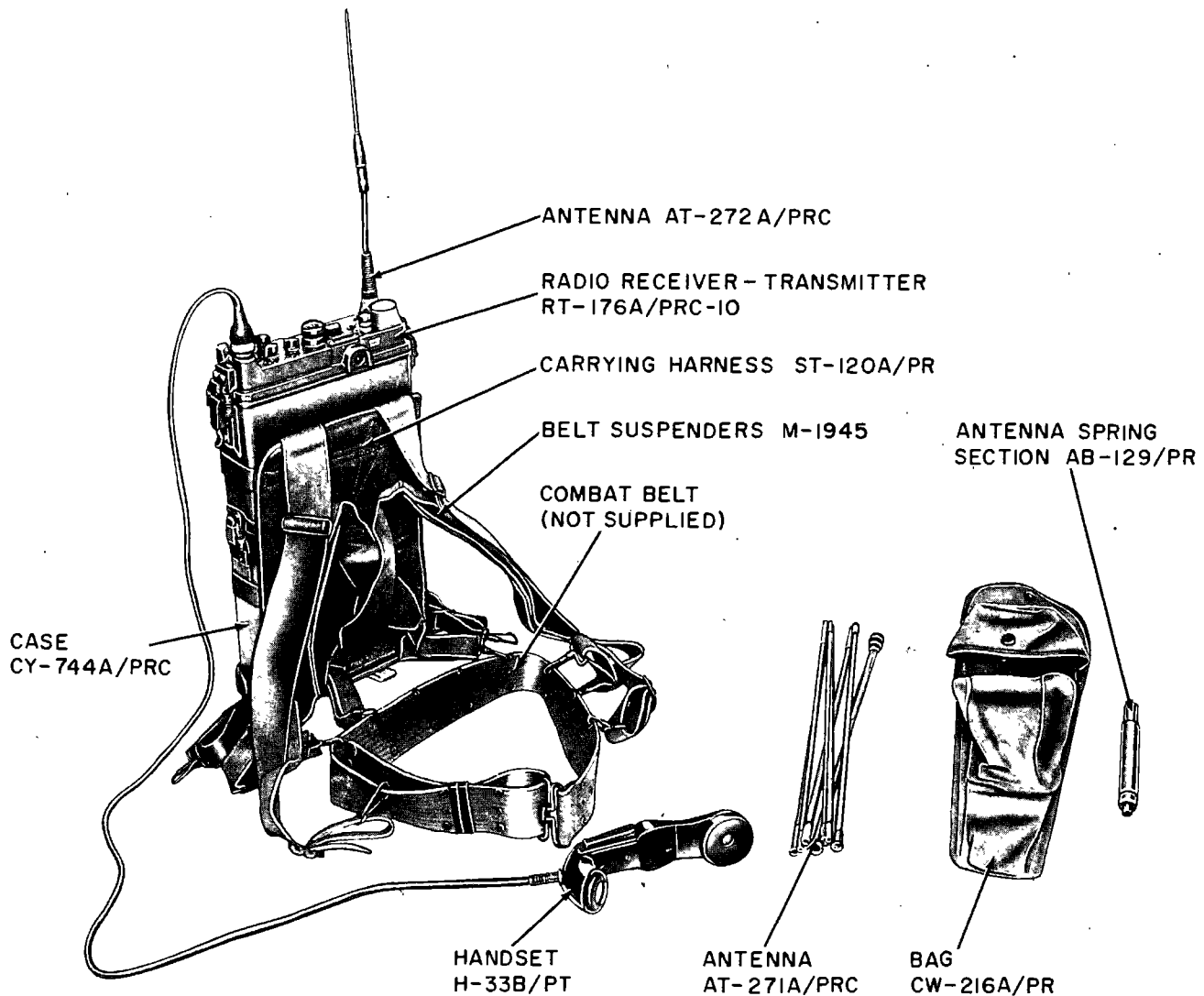


Figure 50. Radio sets AN/PRC-8, -9, and -10.

communication between armor and artillery units. A similar overlap between radio sets AN/PRC-9 and AN/PRC-10 provides 10 channels for communication between artillery and infantry units.

c. Calibration. Continuously tunable throughout the frequency range, each radio set is equipped with a 1-megahertz crystal for calibration. Calibration is accomplished at each whole megacycle appearing on the dial. On later models—the AN/PRC-8A, AN/PRC-9A, and AN/PRC-10A, calibration checkpoints are indicated by markers on the dial. The markers are 2.15 megahertz apart.

d. Characteristics. The general characteristics of radio sets AN/PRC-8, -9, -10, are as follows:

(1) *Emission:* Voice (frequency modulated).

(2) *Rated transmission range:* 5 kilometers with 36 inch antenna or 8 kilometers with 10 foot antenna.

(3) *Frequency range:* AN/PRC-8 (armor); From 20.0 to 27.9 megahertz; AN/PRC-9 (artillery): From 27.0 to 38.9 megahertz; AN/PRC-10 (infantry): From 38.0 to 54.9 megahertz.

(4) *Power supply:* Dry battery BA-279/U (operating life approximately 20 hours) or battery BA-2279/U (for arctic operation).

(5) *Weight:* 26 pounds.

e. Components. The major components of radio sets AN/PRC-8, -9, and -10 are as follows:

(1) For manpack operation—

(a) Radio receiver-transmitter RT-174/PRC-8, RT-175/PRC-9, or RT-176/PRC-10.

(b) Case CY-744/PRC.

(c) Antenna AT-271/PRC.

(d) Antenna AT-272/PRC.

(e) Antenna spring section AB-129/PR.

(f) Belt suspenders M-1945.

(g) Bag CW-216/PR.

(h) Carrying harness ST-120/PR.

(i) Handset H-33/PT.

(2) For vehicular installation kit—

(a) Amplifier-power supply AM-598/U.

(b) Appropriate antenna and connections (see SB 11-131).

f. Installations.

(1) *Pack.* For pack installation, the radio set is fastened to the carrying harness ST-120/PR. The set is placed on the operator's back, and the carrying harness is fastened to a combat or cartridge belt. Dry battery BA-279/U (or BA-2279/U) and antenna AT-272/PRC are necessary for manpack operation.

(2) *Ground.* For ground installation, the radio set is placed upright on the ground with the U-shaped runners on the battery case extended to provide stability. The dry battery is the power supply, and the long antenna AT-271/PRC is used to obtain better operational reliability.

(3) *Vehicular.* The amplifier-power supply AM-598/U is necessary for vehicular installation. The antenna for vehicular installation of radio set AN/PRC-9 (artillery) consists of one mast section MS-116, one mast section MS-117, and one mast section AB-24.

g. References. For information concerning the operation, organizational maintenance, and repair parts, refer to TM's 11-5820-292-10, -20, and -20P.

160. Radio Set AN/VRC-9

a. General. Radio set AN/VRC-9 (fig. 51) is a medium-power, voice-operated, frequency modulated, two-way radio designed for communication between moving or stationary vehicles. This artillery radio set is used by individuals who need only one receiver-transmitter. The armor version of the set is the AN/VRC-8; the infantry version is the AN/VRC-10.

b. Components. The principal components of the AN/VRC-9 are—

(1) Receiver-transmitter RT-67/GRC.

(2) Power supply PP-109/GR or PP-112/GR.

(3) Mounting MT-299/GR.

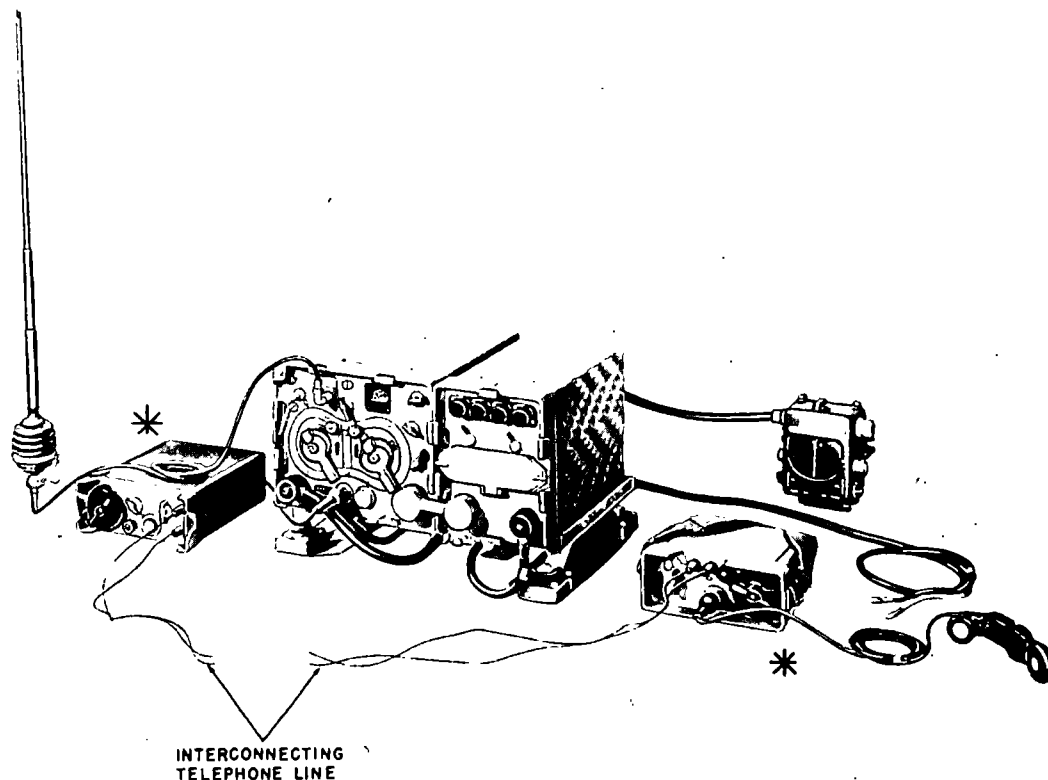
c. Installation. Radio set AN/VRC-9 can be installed and operated in any military vehicle equipped with either a 12- or 24-volt ignition system, but, because of the differences in the vehicles, detailed instructions for the exact location of components, routing of cables, placement of antennas, etc., are not discussed in this manual. For specific details of installation, reference should be made to the instructions supplied with the installation units for the vehicle.

d. Characteristics. The general characteristics of radio set AN/VRC-9 are as follows:

(1) *Emission:* Voice and 1,600-hertz ringing signal (frequency modulated).

(2) *Rated transmission range:* From 16 to 24 kilometers.

(3) *Frequency range:* RT-66/GRC (armor): From 20.0 to 27.9 megahertz; RT-67/GRC (artillery): 27.0 to 38.9 megahertz; RT-68/GRC (infantry): From 38.0 to 54.9 megahertz.



* NOT COMPONENTS

Figure 51. Radio set AN/VRC-9.

(4) *Number of operating channels:* RT-66/GRC (armor): 80 channels; RT-67/GRC (artillery): 120 channels; RT-68/GRC (infantry): 170 channels.

(5) *Tuning:* Detent or continuous tuning with facilities for preselecting two of the operating channels.

(6) *Power supply:* Power supplies PP-109/GR and PP-112/GR are vibrator-type power supplies that derive power from a 12-volt and a 24-volt storage battery, respectively. The power units are designed specifically to provide operating power for receiver-transmitter RT-66/GRC, RT-67/GRC, or RT-68/GRC.

e. References. For additional information concerning radio set AN/VRC-9, see TM 11-286.

161. Radio Set AN/VRC-17

a. Radio set AN/VRC-17 (fig. 52) employs the same components and provides the same facilities as radio set AN/VRC-9 except that it has a larger mounting to accommodate auxiliary receiver

R-109/GRC, which duplicates the frequency coverage of the receiver-transmitter RT-67/GRC. The auxiliary radio receiver makes it possible to box C-375, or the receiver may be operated independently at its own front panel. Since the characteristics and capabilities of the receiver-transmitter RT-67/GRC are described in paragraph 160 only receiver R-109/GRC will be discussed in this paragraph.

b. The general characteristics of receiver R-109/GRC are as follows:

(1) *Frequency range:* 27.0 to 38.9 megahertz.

(2) *Number of operating channels:* 120.

(3) *Type of reception:* Voice and 1,600 hertz ringing tone (frequency modulated).

(4) *Tuning:* Continuous tuning with facilities available for presetting any three of the operating channels.

(5) *Power supply:* Internally installed. Power supplies PP-448-GR, 6 volts; PP-281/GR, 12 volts; and PP-282/GRC, 24 volts.

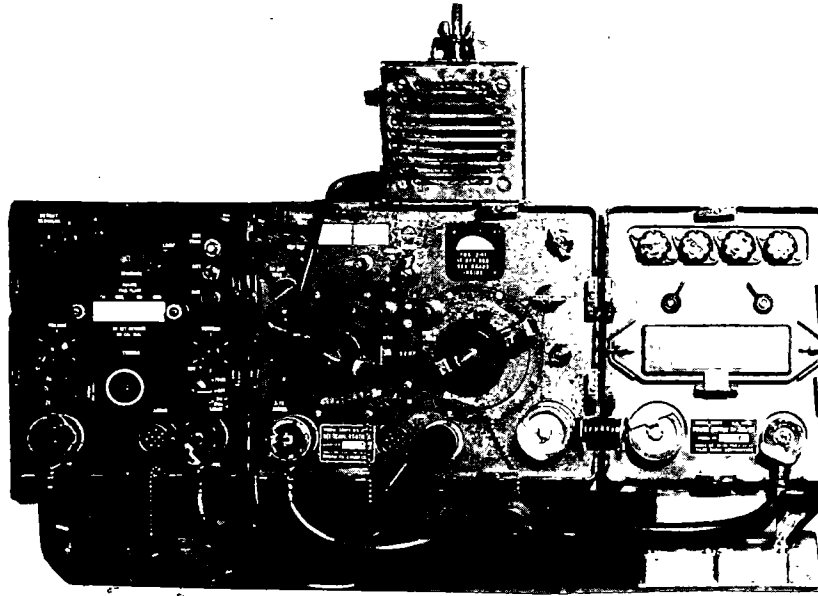


Figure 52. Radio set AN/VRC-17.

c. For further information pertaining to radio set AN/VRC-17, see TM 11-611.

162. Radio Set AN/VRQ-2

a. Radio set AN/VRQ-2 (fig. 53) consists of two receiver-transmitters RT-67/GRC, two power supplies PP-109/GR (12 volt) or PP-112/GR (24 volt), mounting MT-298/GR, and a retransmission unit, control C-435/GRC. The technical characteristics and operational capabilities of the receiver-transmitters are identical with those of the RT-67/GRC used with radio set AN/VRC-9 (para 160). The terms "set 1" and "set 2" are used to distinguish between the two receiver-transmitters. Set 1 refers to the left- and receiver-transmitter and power supply, set 2 refers to the right- and receiver-transmitter and power supply (facing the set).

b. The capabilities of radio set AN/VRQ-2 are as follows:

(1) *Monitor or transmit on two frequencies.* Monitoring or transmitting on two frequencies with two receiver-transmitters RT-67/GRC (set 1 and set 2) is accomplished in the same manner as with one receiver-transmitter.

(2) *Automatic retransmission.* Automatic retransmission is defined as the capability of the radio set to operate as an automatic relay station, receiving signals on one receiver-transmitter and automatically retransmitting the same signals on

the other receiver-transmitter. In order to effect automatic retransmission, the retransmission unit, control C-435/GRC, must be installed in the mounting bracket.

(3) *Duplex operation.* The retransmission unit C-435/GRC provides the switching circuits required for duplex operation. Duplex operation is the capability of the radio set to provide simultaneous communication in two directions. For duplex operation, the AUTO switch is turned to the DUPLEX position. This action turns on set 1 and keys it continuously; set 2 then acts as a receiver only.

c. For further information pertaining to radio set AN/VRQ-2, see TM 11-287.

163. Radio Sets AN/VRC-12 and AN/VRC-43 Through -49

a. Radio sets AN/VRC-12 and AN/VRC-43 through -49 are the most recent vehicular radio communication equipment designed for armor, artillery, and infantry units. The radio sets are frequency modulated and will replace radio sets AN/GRC-3 through -8, AN/VRC-7 through -10, AN/VRC-13 through -18, AN/VRC-20 through -22, and AN/VRQ-1 through -3. All configurations of the new radio sets consist of various combinations of two basic components—a receiver-transmitter and an auxiliary receiver. There are two versions of the receiver-transmitter—a man-

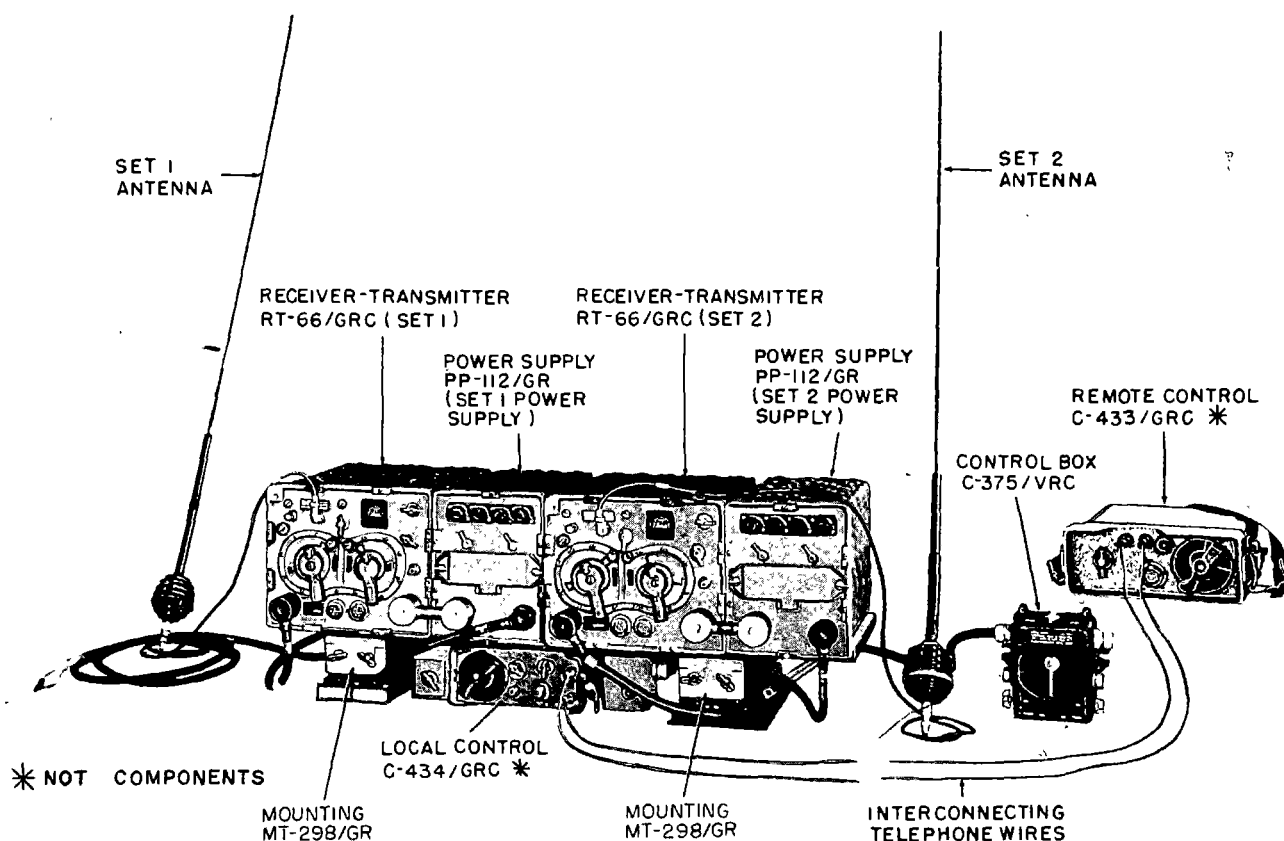


Figure 53. Radio set AN/VRQ-2.

ually tuned model, the RT-524/VRC, and an automatically tuned model, the RT-246/VRC-9 (fig. 54). Both models have the same characteristics. The manual model contains a built-in loudspeaker in the space occupied by the pushbuttons of the automatic model. The manually tuned RT-524/VRC was developed primarily for issue to artillery and infantry units, since their need for a self-contained loudspeaker is greater than their need for automatic tuning. Armor units will be issued the automatic receiver-transmitter RT-246/VRC because of limited access in tracked vehicles. Any of the 10 preset channels can be remotely selected from crew positions. The auxiliary receiver R-442/VRC is manually tuned. Each component of the new radio sets has its individual mount. Tone squelch (NEW SQUELCH POSITION) prevents this series radios from netting with the AN/PRC and VRC-8, -9, and -10 series radios and with many army aircraft FM radios. The older family of radios is unable to communicate through the 150 HZ tone squelch of the 12 series radios whenever the squelch switch is in the NEW SQUELCH POSITION.

b. The characteristics of receiver-transmitters RT-524/VRC and RT-246/VRC are as follows:

- (1) *Frequency range*: From 30.00 to 75.95 megahertz.
 - (a) *Band A*: From 30.00 to 52.95 megahertz.
 - (b) *Band B*: From 53.00 to 75.95 megahertz.
- (2) *Preset channels*: 10 (RT-246/VRC only).
- (3) *Number of channels*: 920.
- (4) *Channel spacing*: 50 kilohertz.
- (5) *Type of modulation*: Frequency modulation (FM).
- (6) *Type of transmission and reception*: Voice.
- (7) *Transmitter power output*:
 - (a) *High power*: 35 watts, minimum.
 - (b) *Low power*: 1 to 3 watts.
- (8) *Distance range (high power)*:
 - (a) *Stationary*: 32 kilometers.
 - (b) *Moving*: 24 kilometers.

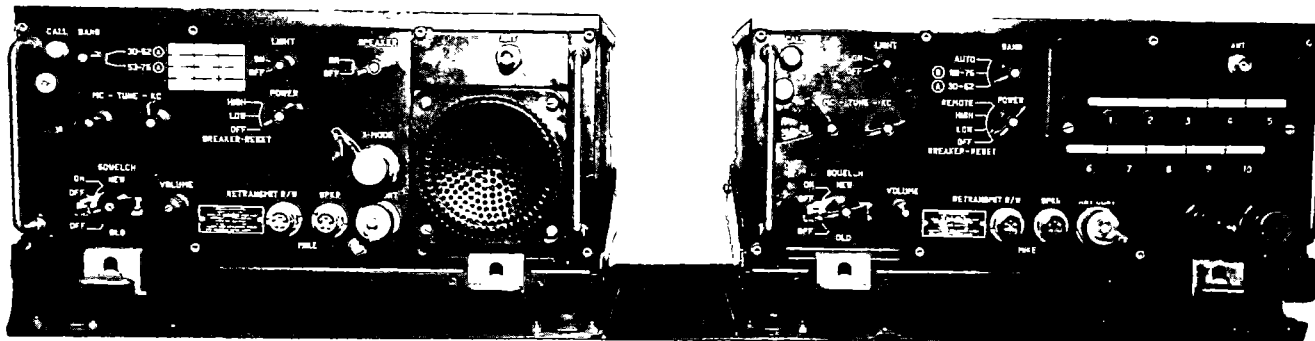


Figure 54. Radio receiver-transmitters RT-524/VRC and RT-246/VRC.

(9) *Input power requirements:*

(a) *High power:* 10 amperes at 24 volts direct current.

(b) *Low power:* 3 amperes at 24 volts direct current.

(10) *Antenna:* Center-fed whip.

(11) *Types of squelch:* Noise and tone operated.

c. The characteristics of radio receiver R-442/VRC are as follows:

(1) *Frequency range:*

(a) *Band A:* From 30.00 to 52.95 megahertz.

(b) *Band B:* From 53.00 to 75.95 megahertz.

(2) *Number of channels:* 920.

(3) *Channel spacing:* 50 kilohertz.

(4) *Type of modulation:* Frequency modulation.

(5) *Type of signal received:* Voice.

(6) *Types of squelch:* Noise and tone operated.

(7) *Antenna:* Three-section whip (one MS-116, one MS-117, and one MS-118).

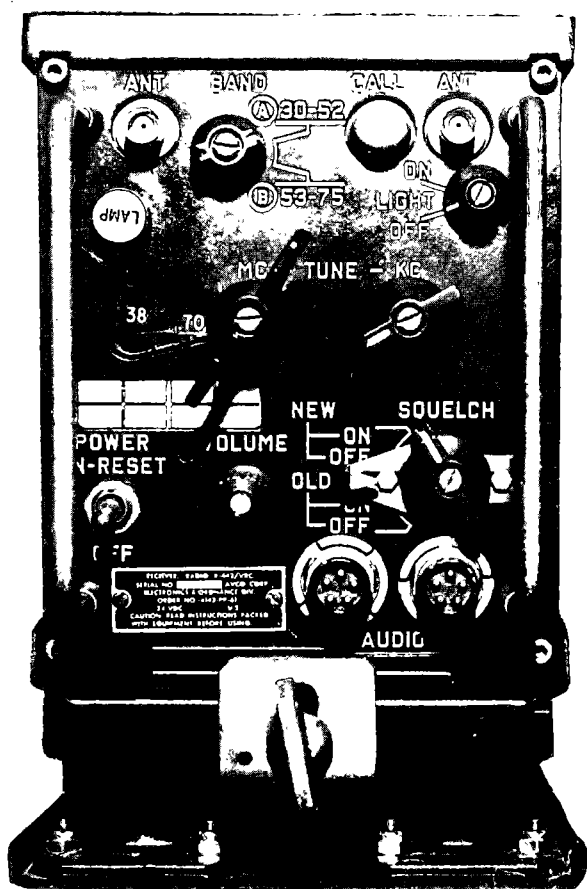


Figure 55. Radio receiver R-442/VRC.

164. Radio Receiver R-442/VRC

Radio Receiver R-442/VRC (fig. 55) is a rugged, lightweight, compact receiver housed in a watertight case. All operating controls are located on the front panel. An electrical connector at the rear mates with a connector on the mount MT-1898/VRC. Two guide pin holes at the rear are recessed for the guide pins on the mount. The top and bottom covers are held in place by captive screws. The receiver is part of radio sets AN/VRC-12, AN/VRC-44, AN/VRC-47 and AN/VRC-48.

165. Radio Receiver-Transmitter RT-246/VRC

Receiver-transmitter RT-246/VRC (fig. 54) is a rugged, lightweight, compact receiver-transmitter housed in a watertight case. All operating controls are located on the front panel. The hinged cover, held in place by two captive screws in front of the pushbutton assembly, provides access to the pre-setting adjustments for maintenance personnel. The connector at the rear mates with a connector

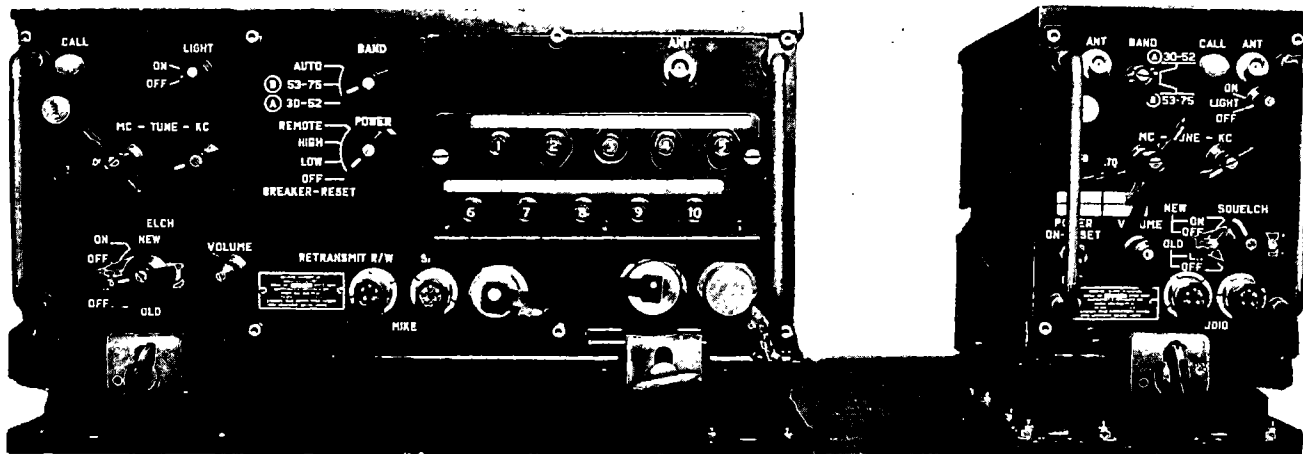


Figure 56. Radio set AN/VRC-12.

on the front of the junction box on mount MT-1029/VRC. Two guide pin holes are recessed for the guide pins on the mount. The blower inside the case aids in dissipating heat. The top and bottom covers are held in place by captive screws.

166. Radio Receiver-Transmitter RT-524/VRC

Receiver-transmitter RT-524/VRC (fig. 54) is similar to receiver-transmitter RT-246/VRC

except that it has a self-contained loudspeaker instead of a pushbutton assembly on the front panel.

167. Radio Set AN/VRC-12

Radio set AN/VRC-12 (fig. 56) provides facilities for monitoring two channels simultaneously or for monitoring one channel while transmitting on another. It has 10 preset channels. For additional information on radio set AN/VRC-12, refer to TM 11-5820-401-10.

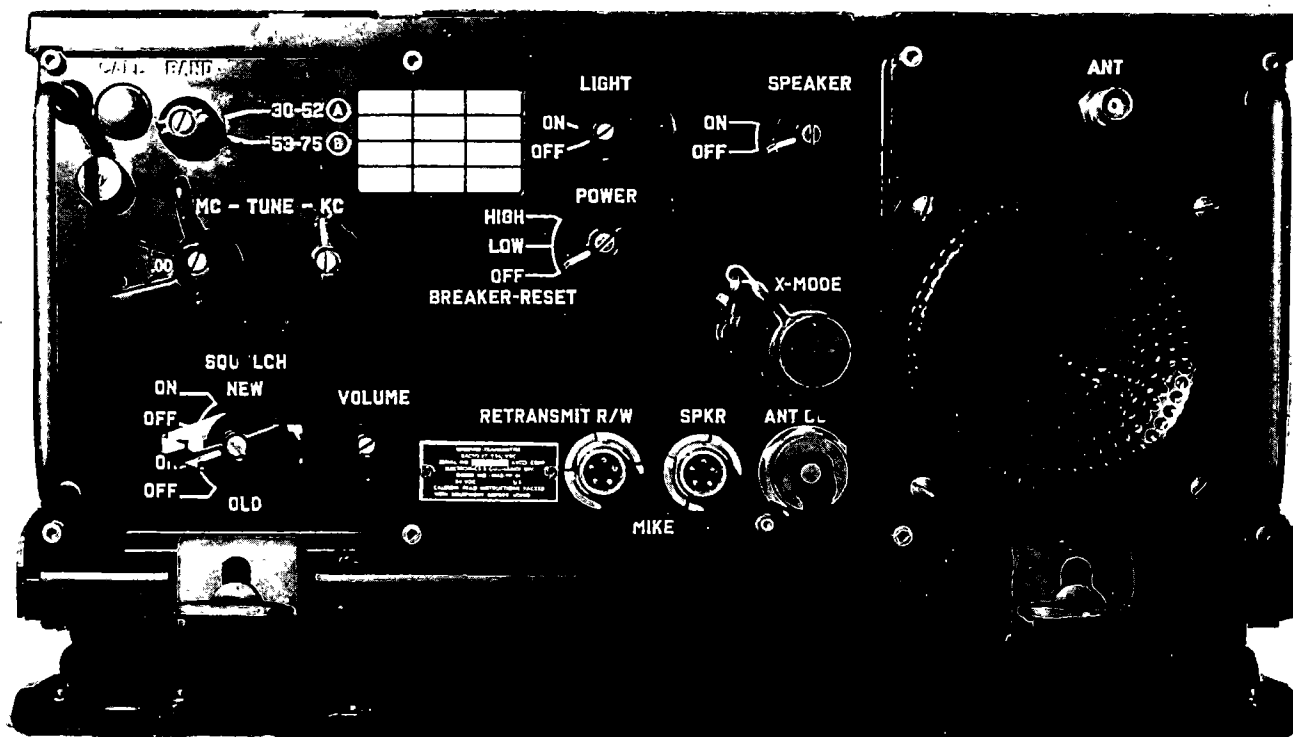


Figure 57. Radio set AN/VRC-46.

168. Radio Set AN/VRC-46

a. General. Radio set AN/VRC-46 (fig. 57) is similar to the AN/VRC-47 except for the absence of auxiliary receiver R-442/VRC. It is a manually tuned radio set.

b. Components. The principal components of the AN/VRC-46 are—

- (1) Radio receiver-transmitter RT-524/VRC.
- (2) Mounting MT-1029/VRC.
- (3) Antenna AT-912/VRC (replaced by AS-1729).

c. Characteristics and Capabilities. See paragraph 163 for the characteristics and capabilities of radio set AN/VRC-46.

169. Radio Set AN/VRC-47

a. General. Radio set AN/VRC-47 (fig. 58) provides facilities for monitoring two channels simultaneously or for monitoring one channel while transmitting on another. It is a manually tuned radio set.

b. Components. The principal components of the AN/VRC-47 are—

- (1) Radio receiver-transmitter RT-524/VRC.
- (2) Radio receiver R-442/VRC.
- (3) Mounting MT-1029/VRC.

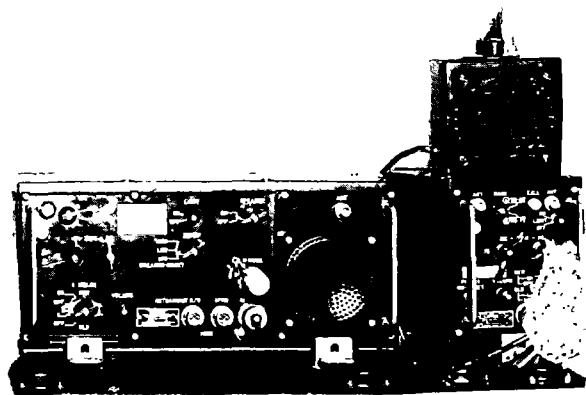


Figure 58. Radio set AN/VRC-47.

- (4) Mounting MT-1898/VRC.

- (5) Antenna AT-912/VRC (replaced by AT-1729).

c. Characteristics and Capabilities. See paragraph 163 for the characteristics and capabilities of radio set AN/VRC-47.

170. Radio Set AN/VRC-49

a. General. Radio set AN/VRC-49 (fig. 59) provides facilities for monitoring two channels simul-

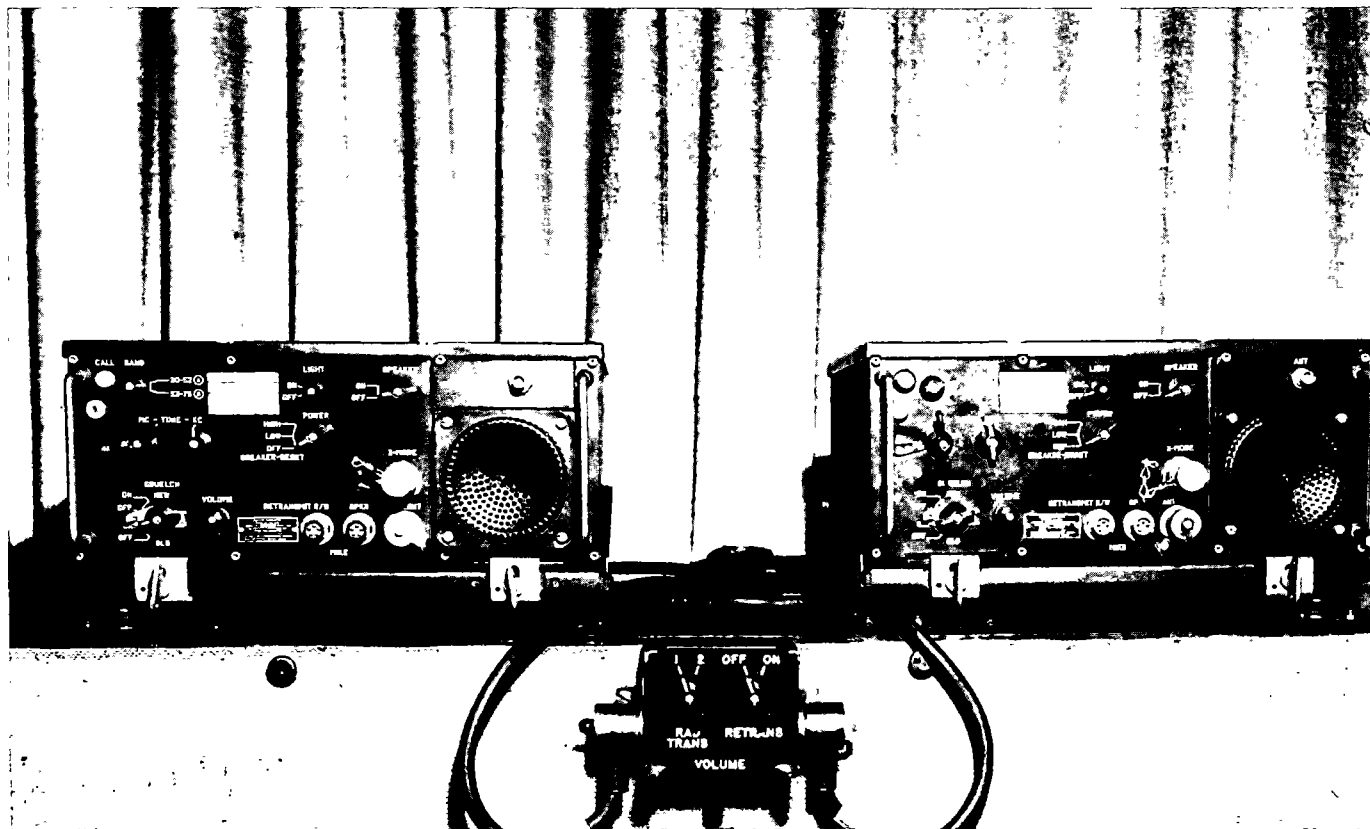


Figure 59. Radio set AN/VRC-49.

taneously, transmitting on two channels simultaneously, or monitoring one channel while transmitting on another. In addition, the radio set control C-2299/VRC is used to control automatic retransmission between two distant stations.

b. Components. The principal components of the AN/VRC-49 are as follows:

(1) Two radio receiver-transmitters RT-524/VRC.

(2) Two mountings MT-1029/VRC.

(3) Two antennas AT-912/VRC (replaced by AS-1729).

(4) One radio set control C-2299/VRC.

c. Characteristics and Capabilities. See paragraph 163 for the characteristics and capabilities of radio set AN/VRC-49.

171. Radio Set AN/PRC-25

a. General. Radio set AN/PRC-25 (fig. 60) is both a portable and a vehicular-mounted FM receiver-transmitter designed to replace the present radio sets AN/PRC-8, -9, and -10. It is powered by a dry battery or by a special vehicular power supply. Radio set AN/PRC-25 will net with the AN/VRC-12 series, but not with old series radios unless receiver is operated without tone squelch (SQUELCH switch in the OFF POSITION). It is, however, a smaller set than the 12 series designed to operate over shorter distances. The basic radio set is referred to simply as the AN/PRC-25; however, recent nomenclature assignments have made the following distinctions in the use of the basic radio receiver-transmitter RT-505/PRC-25:

(1) When issued with the components for manpack operation only, the radio is referred to as radio set AN/PRC-25.

(2) When issued with the components for vehicular operation only, the radio is referred to as radio set AN/VRC-53.

(3) When issued with the components for manpack or vehicular operation, the radio is referred to as radio set AN/GRC-125.

b. Characteristics. The characteristics of radio receiver-transmitter RT-505/PRC-25 are as follows:

(1) *Frequency range:*

(a) *Low band*—30.00 to 52.95 megahertz.

(b) *High band*—53.00 to 75.95 megahertz.

(2) *Preset channels:* two.

(3) *Number of channels:* 920.

(4) *Channel spacing:* 50 kilohertz.

(5) *Type of modulation:* Frequency modulation.

(6) *Type of transmission and reception:* Voice.

(7) *Transmitter power output:* 1.5 to 2.0 watts.

(8) *Type of squelch:* Tone operated.

(9) *Operating range:* 8 kilometers.

(10) *Antennas:*

(a) AN/VRC-53: AT-912/VRC (or AS-1729), center-fed whip.

(b) AN/GRC-125: AT-912/VRC (or AS-1729), center-fed whip; AT-271A/PRC, 10-foot multisection whip; AT-892/PRC-25, 3-foot semirigid tape.

(c) AN/PRC-25: AT-271A/PRC, 10-foot multisection whip; AT-892/PRC-25, 3 foot semirigid tape.

(11) *Battery life:* 20 hours with a 9-to-1 receive-transmit ratio.

(12) *Power supply:* Amplifier-power supply group OA-3633/GRC used with AN/VRC-53 and AN/GRC-125. Input voltage is 24 volts direct current. External battery cap can be removed to use an outside power source, but when using internal battery power, cap must be in position to complete circuit.

172. Radio Receiver-Transmitter RT-505/PRC-25

Radio receiver-transmitter RT-505/PRC-25 (fig. 60) is housed in a watertight metal case, and secured with four captive screws. All controls are on the front panel. A battery plug projects from the RT-505/PRC-25 and mates with the connector of battery BA-386/U. Battery box CY-2562/PRC-25 is part of the RT-505/PRC-25. It is a lightweight, metal case that houses and protects the battery BA-386/U. The battery rests on a foam rubber pad fastened to the bottom of the case. The long life magnesium battery, BA-4386 (FSN 6135-926-8322), can also be used with this radio.

173. Retransmission Cable Kit MK-456/G

Two radio sets AN/PRC-25 at a suitable location may be used to retransmit automatically the signals of two other radio sets that are too far apart to communicate directly with each other. This action can be accomplished by connecting the retransmission cable kit MK-456 between the two AN/PRC-25's. The MK-456/G consists of a 50-foot cable with a 5-pin connector at each end and a

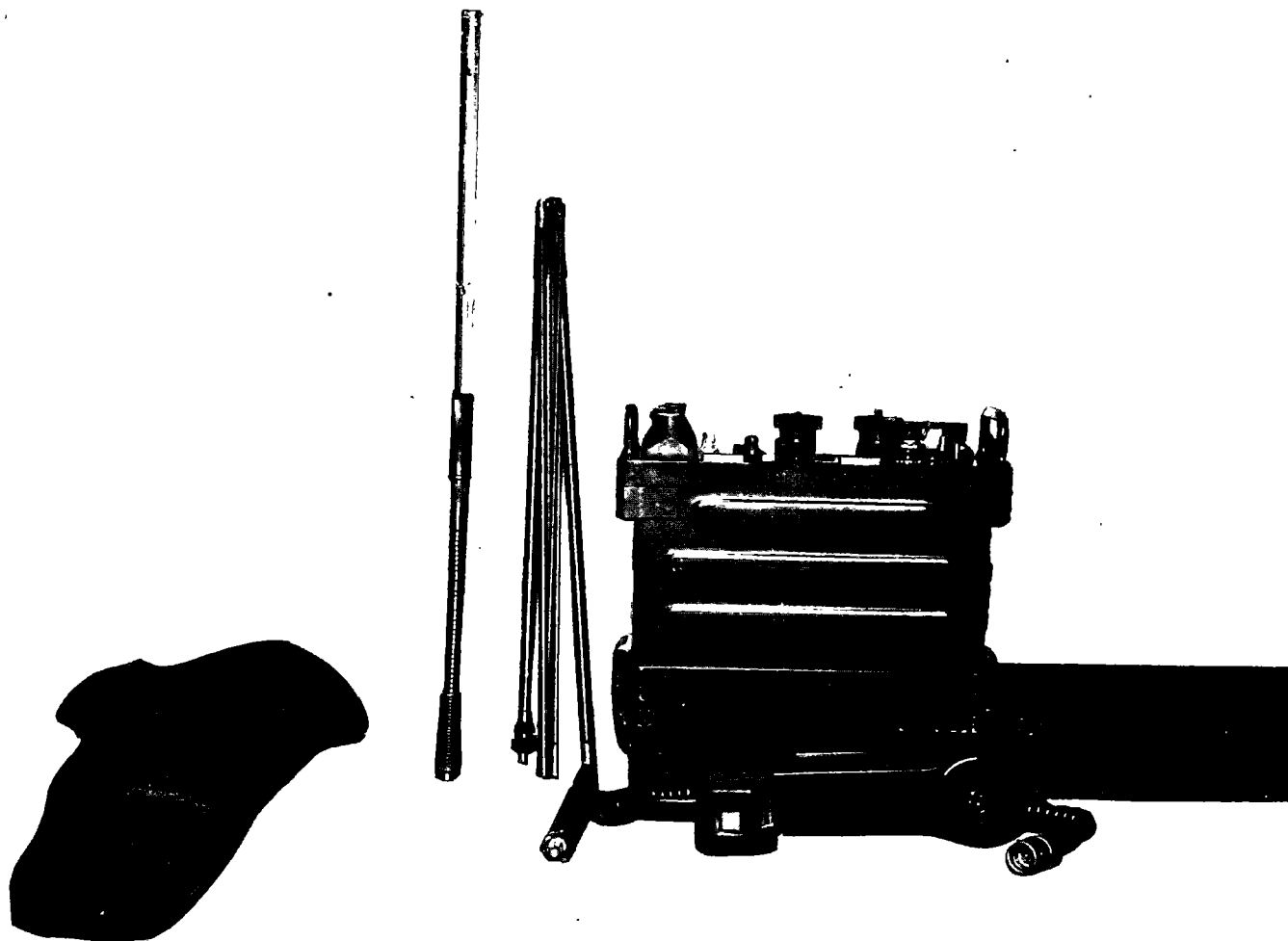


Figure 60. Radio set AN/PRC-25 or AN/PRC-77.

junction box at the center. The junction box has a connector for handset H-138/U which permits the operator to monitor the retransmission signals. For additional information, refer to TM 11-5820-389-12.

174. Radio Set AN/PRC-77

a. When radio set AN/PRC-25 is operated in the same vehicle with another AN/PRC-25 or with a radio set of the VRC-12 series of radios, mutual interference and channel blockage can occur. In order to reduce such mutual interference, the PRC-77 has been developed. It is identical in external appearance to the AN/PRC-25. The AN/PRC-77 will eventually replace the AN/PRC-25 on an attrition basis; however, AN/PRC-25 radio sets under purchasing contract are not affected and those now in the hands of troops will continue in service.

b. Receiver-transmitter RT-841()/PRC-77 (formerly receiver-transmitter RT-505/PRC-25, modified) is a short-range, manpack, frequency modulated receiver-transmitter unit in a water-tight case. The receiver-transmitter may be manually tuned from the front panel to any frequency in the range of 30.00 to 75.95 megahertz in increments of 50 kilohertz. The equipment is fully transistorized with modular construction and printed wiring. Radio-frequency amplifier AM-4306/PRC extends the range of receiver-transmitter RT-841()/PRC-77 from a normal 5 to 8 kilometers to 16 to 20 kilometers when carried on a man's back and to 24 to 32 kilometers when the receiver-transmitter is vehicular mounted.

c. The following chart shows the basic AN/PRC-25 radio set and the AN/PRC-77 radio, including the nomenclature of the various configurations:

JB 704-20.
SRC 06 + 3

Basic components	Manpack only	Vehicular mounting only	Manpack or vehicular mounting
RT-505/PRC-25	AN/PRC-25	AN/VRC-53	AN/GRC-125
RT-841/PRC-77	AN/PRC-77	AN/VRC-64	AN/GRC-160
RT-841/PRC-77	AN/PRC-79	AN/VRC-65	AN/GRC-161
and AM-4306/PRC			
RT-505/PRC-25	AN/PRC-80	AN/VRC-66	AN/GRC-162
and AM-4306/PRC			

d. For further information, see TM 11-5820-667-12.

175. Radio Set AN/PRC-74()

The initial version of radio set AN/PRC-74 (fig. 61) operates at a frequency range of 2.0 to 11.999 megahertz. The modified AN/PRC-74B provides dependable two-way communications within the frequency range of 2.0 to 18.0 megahertz. This is a single-sideband (SSB) receiver-transmitter RT-794/PRC-74 which provides either voice or telegraph continuous wave (CW) communication. Since the radio set operates at the low end of the high-frequency spectrum, signals are propagated by both the ground wave method and the sky wave method. Ground wave propagation normally is used for communication at distances up to 40 kilometers. For greater distances sky wave propagation is used, and signals reach distant points by

refraction from the ionosphere. The operating range of this radio set may be extended to several hundred kilometers by proper selection of frequency, antenna and time of day. This radio set is primarily designed for use as a manpack set in areas where direct line-of-sight communication is difficult. The set may be operated with a 12-volt portable unit battery pack (nickel-cadmium) or a dry battery pack, consisting of 70 batteries BA-30 or 2 batteries BA-386. For fixed installations with 110/220 volt, AC, single phase power, power supply PP-4514/PRC-74 can be used. For further information, see TM 11-5820-590-12-1.

176. Squad Radio Set AN/PRC-88

a. Radio set AN/PRC-88 consists of radio transmitter AN/PRT-4 ((1), fig. 62) and radio receiver AN/PPR-9 ((2) fig. 62). When used together these two components provide one-way, short range, portable radio communications. This radio set is battery operated, frequency modulated, crystal controlled, and designed for use in the 47 to 57 megahertz frequency band. The operating frequencies are determined by the crystals installed in the receiver and transmitter. Planning range for operation in Channel 1, high power, is 1600 meters and Channel 2, low power, 500 meters. The receiving set AN/PPR-9 is designed for quick attachment to and use on the standard helmet. It receives voice and tone-modulated signals on a preset channel. An audio horn trans-

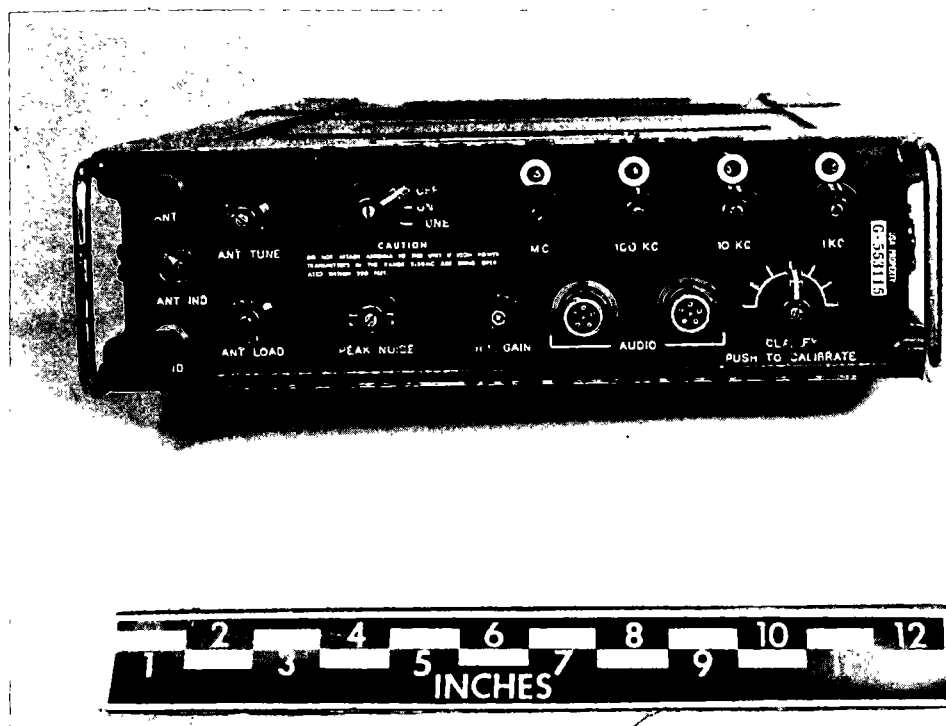


Figure 61. Radio set AN/PRC-74().

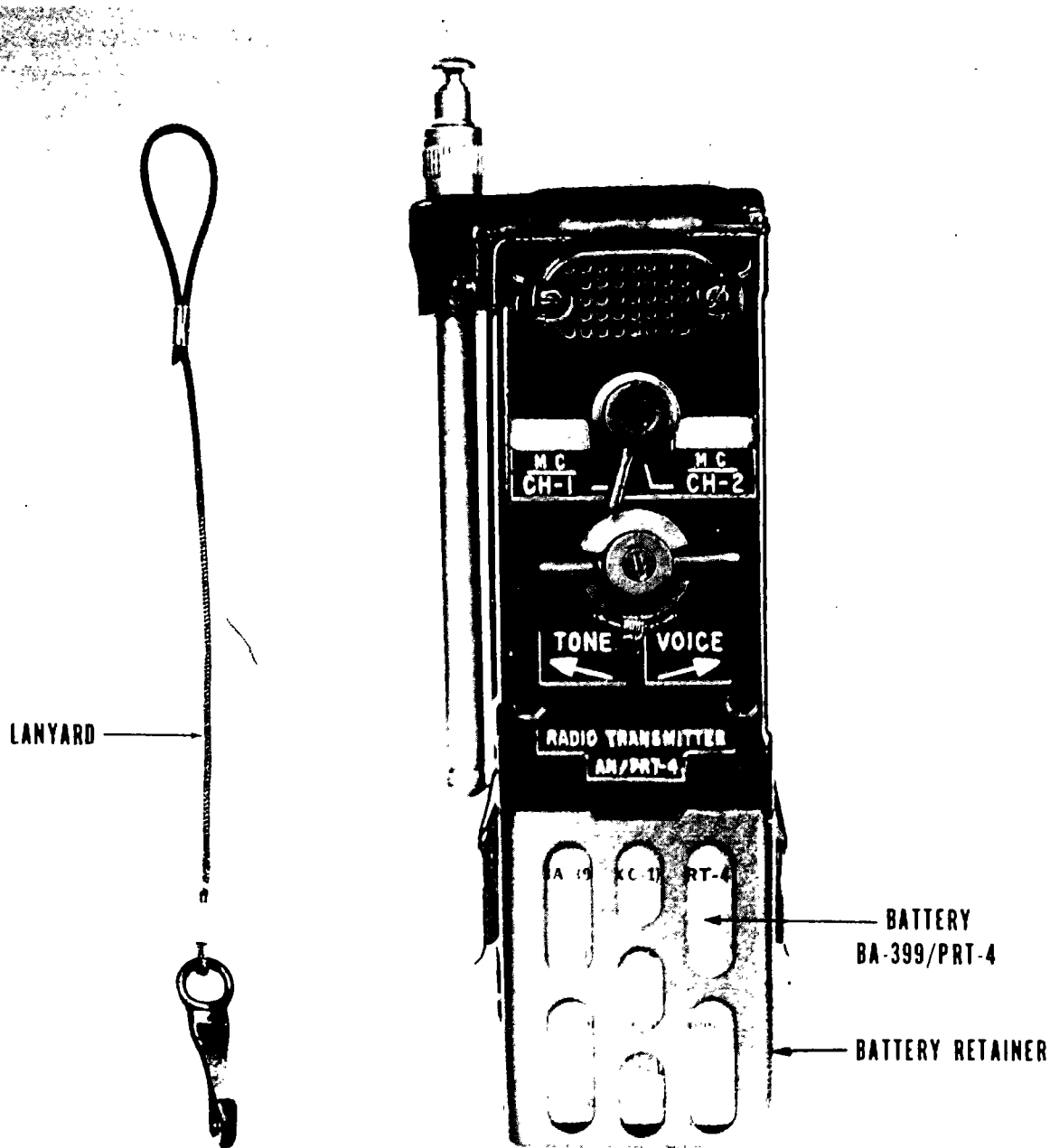
ducer is attached to the side of the receiver and directs sound under the rim of the helmet toward the operator's ear.

b. If reduced range is acceptable, the receiver also may be carried in a shirt pocket or clipped to a harness. A headset can be furnished for special purposes. The transmitter AN/PRT-4 is a handheld, dual-channel unit. It transmits either audio tone or voice communications on either of two channels. When not in use, it may be clipped to a pocket or belt. A lanyard may also be used to prevent loss.

c. For further information, see TM 11-5820-549-12.

177. Radio Set AN-GRC-106

a. *General.* Radio set AN/GRC-106 (fig. 63) is a high frequency, single-sideband (SSB), receiving-transmitting radio set. It operates on any one of 28,000 selectively tuned channels, spaced in 1 kilohertz increments in the 2.000 to 29.999 megahertz frequency range. The additional feature of vernier tuning (+ or -500 hertz about any 1 kilohertz increment) allows reception on any fre-



1 Radio transmitter AN/PRT-4

Figure 62. Part of radio set AN/PRC-88.

ANTENNA RETAINING SCREW

TUNE ANTENNA
LOADING COIL

REMOVE THESE 4 SCREWS
TO CHANGE TRANSDUCER

REMOVE THESE 2 SCREWS
TO REMOVE RECEIVER CHASSIS

EARPHONE JACK COVER

ON-OFF VOLUME
SQUELCH CONTROL

2 Radio receiver AN/PRR-9

Figure 62—Continued.

quency in the operating frequency range. This insures compatibility with existing amplitude modulated and radio-teletype equipment.

b. Use. The AN/GRC-106 is used for receiving and transmitting upper sideband (USB) voice, USB compatible amplitude modulated (AM) and continuous wave signals on push-to-talk operation over an 80 kilometer range, ground wave and up to 2400 kilometers skywave. Conventional double-sideband (DSB) amplitude modulated signals can be received but not transmitted. Frequency-shift-keyed (FSK) and narrow frequency-shift-keyed

(NSK) signals can be received and transmitted by using appropriate ancillary radio-teletype equipment.

c. Components. The components of the AN/GRC-106 are receiver-transmitter RT-662/GRC, radio-frequency amplifier AM-3349/GRC-106, mounting MT-3140/GRC-106, a standard 15-foot whip antenna group AN/GRA-50, and an installation kit.

d. References. For additional information, see TM 11-5820-520-12.

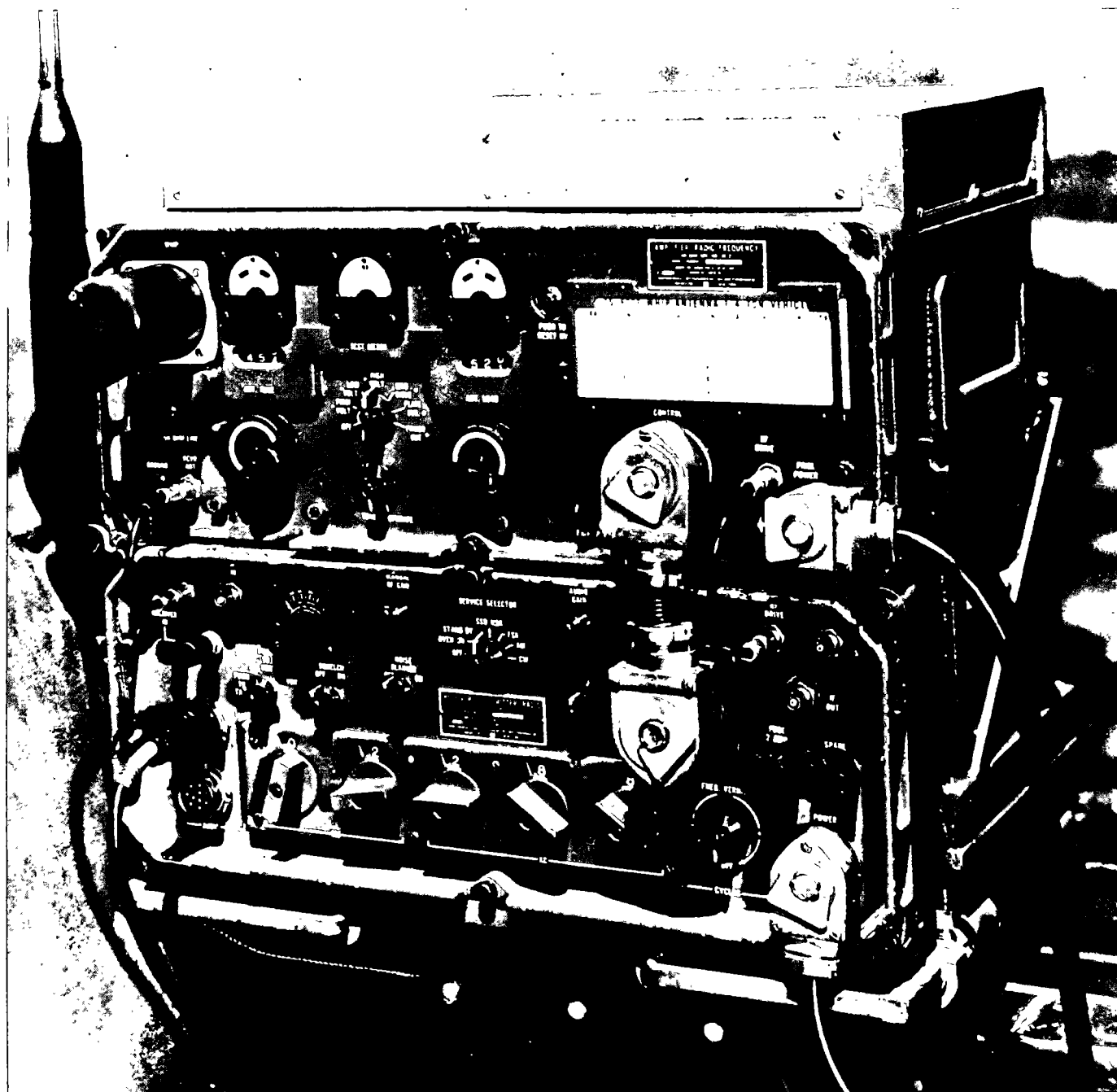


Figure 63. Radio set AN/GRC-106.

178. Radio Teletypewriter Set AN/GRC-142

a. General. Radio teletypewriter set AN/GRC-142 (fig. 64) is installed in electrical equipment shelter S-318()/G, which is mounted on a $\frac{3}{4}$ -ton vehicle. The radio components are the same as those employed in radio set AN/GRC-106 (para 177). Additional equipment is provided for radio teletypewriter (RATT) communication. The AN/GRC-142 has the capability of providing a half duplex circuit using upper-sideband voice, upper sideband compatible AM, continuous wave, frequency-shift-keyed, and narrow frequency-shift-keyed signals. Primary power is provided by the vehicle, which is equipped with a high-capacity (100 amperes), 28-volt electrical system. The AN/GRC-142 was designed to replace radio teletypewriter set AN/GRC-46().

b. Major Components. The major components of radio teletypewriter set AN/GRC-142 are as follows:

- (1) Receiver-transmitter RT-662()/GRC.
- (2) Radio-frequency amplifier AM-3349()/GRC-106.
- (3) Radio teletypewriter modem unit MD-552()/GR.
- (4) Teletypewriter set TT-98/FG.
- (5) Teletypewriter reperforator-transmitter TT-76()/GGC.
- (6) Electrical equipment shelter S-318()/G.
- (7) Inverter, motor generator.
- (8) Air conditioner (6,000 BTU).

c. Characteristics. The characteristics of radio teletypewriter set AN/GRC-142 are as follows:

- (1) Receiver-transmitter RT-662/GRC.
 - (a) *Number of electron tubes:* Two.
 - (b) *Number of transistors:* 142.
 - (c) *Frequency range:* From 2.0 to 29.999 megahertz.
 - (d) *Channels:* 28,000 in locked 1 kilohertz steps.
 - (e) *Types of transmission:* Upper sideband voice, upper-sideband compatible AM, continuous wave, frequency-shift-keyed, and narrow frequency-shift-keyed.
 - (f) *Type of reception:* Upper-sideband compatible and conventional double-sideband AM, continuous wave, frequency-shift-keyed and narrow frequency-shift-keyed.
 - (g) *Type of Control:* Crystal-controlled synthesizers referenced to a highly stable 5 MHz internal standard.
 - (h) *Power source:* 28 volts DC.

(2) *Radio-frequency amplifier AM-3349()/GRC-106.*

- (a) *Number of electron tubes:* Three.
- (b) *Number of transistors:* 10.
- (c) *Frequency range:* From 2.0 to 29.999 megahertz.
- (d) *Power source:* 28 volts DC.
- (e) *Power output:*

1. Continuous wave and radio teletypewriter (FSK and NSK), 200 watts average.

2. Upper-sideband voice and compatible AM voice, 400 watts peak envelope power (PEP).

(f) *Planning range.* 50 miles (80 km) ground wave; up to 1,500 miles (2,400 km) sky wave under suitable propagation conditions and with the proper choice of frequencies, antennas and time of day.

(g) *Types of antennas:*

1. Whip, 15 feet long (three MS-116's, one MS-117, and one MS-118).
2. Doublet, AN/GRA-50.

(3) *Radio teletypewriter modem unit MD-552()/GR.*

- (a) *FSK:* Frequency shift 850 hertz.
- (b) *NSK:* Frequency shift 85 hertz.

(4) *Inverter, motor generator.* The rotary inverter converts 28 volts DC to 115 volts AC at 60 hertz for the teletypewriter equipment.

d. References. For further details, see TM 11-5815-334-12.

179. Radio Teletypewriter Set AN/GRC-122

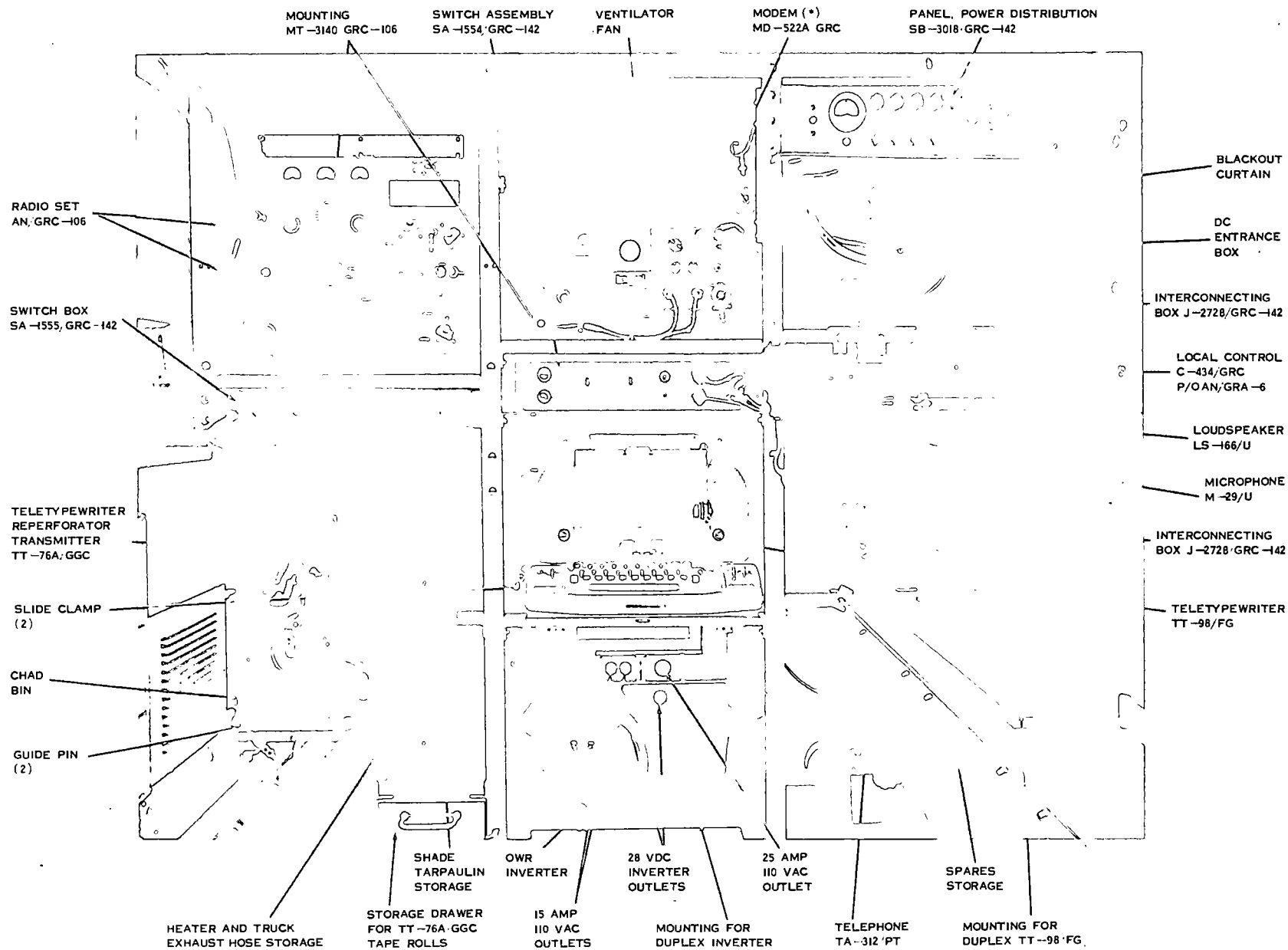
Radio teletypewriter set AN/GRC-122 (fig. 65) and radio teletypewriter set AN/GRC-142 are similar except that the AN/GRC-122 has an additional RT-662()/GRC, teletypewriter set TT-98/FG, and inverter. The AN/GRC-122 has the additional capability of providing full-duplex operation in all types of service.

180. Radio Teletypewriter Set AN/VSC-3

Radio teletypewriter set AN/VSC-3 (fig. 66) and radio teletypewriter set AN/GRC-142 are identical except that the AN/VSC-3 is arranged and mounted in an armored vehicle M577 and does not have an independent shelter.

181. Radio Teletypewriter Set AN/VSC-2

Radio teletypewriter set AN/VSC-2 (fig. 67) is a vehicular-mounted set installed in a $\frac{1}{4}$ -ton vehicle. The radio components of the AN/VSC-2 are the same as those employed in radio set AN/



TM 5815 334-42 1

Figure 64. Radio teletypewriter set AN/GRC-142.



Figure 65. Radio teletypewriter set AN/GRC-122.

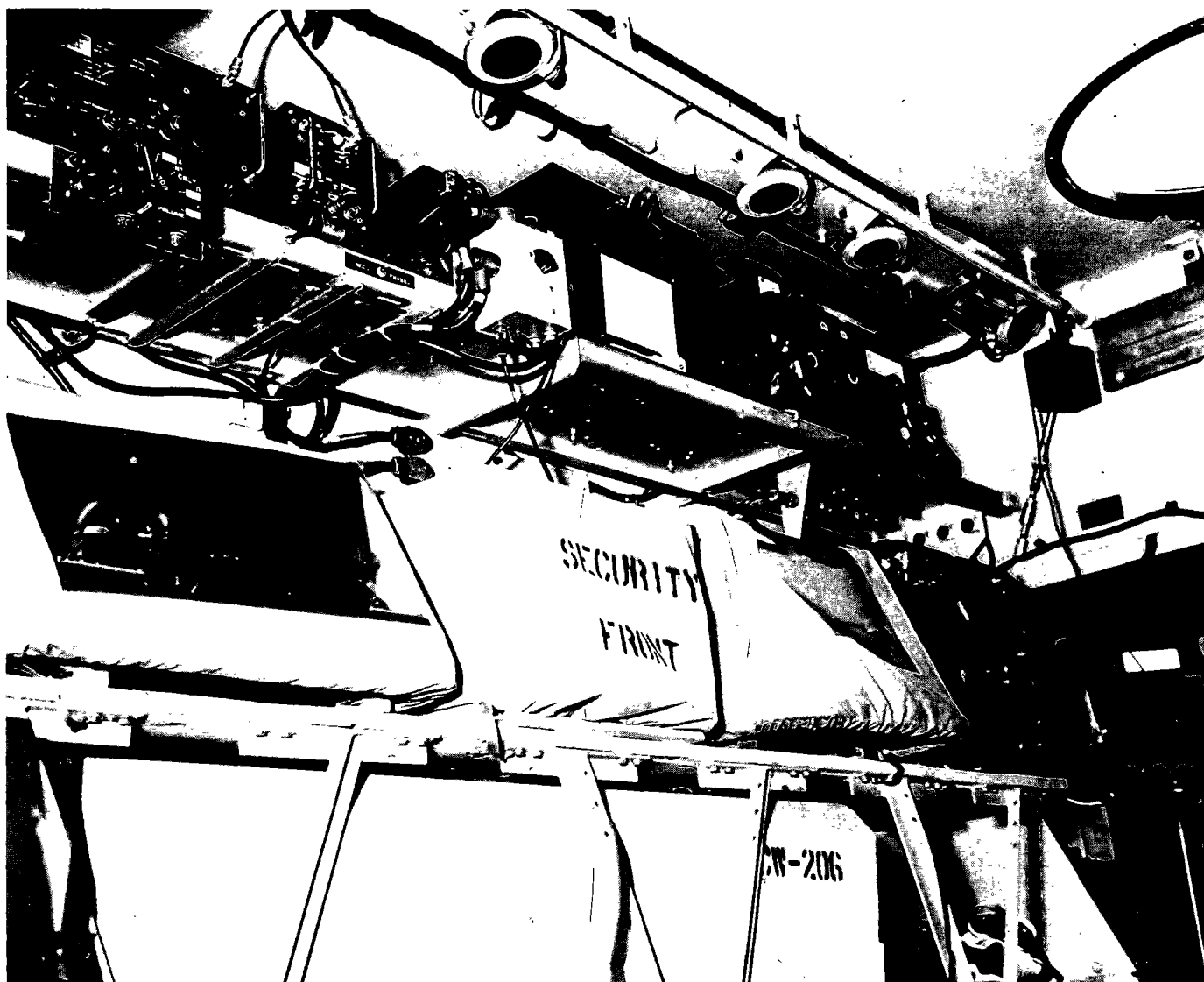


Figure 66. Radio teletypewriter set AN/VSC-3.

GRC-106. Additional equipment is provided for radio teletypewriter communication. The AN/VSC-2 has the same characteristics and facilities as the AN/GRC-142 except that it does not include the teletypewriter reperforator-transmitter TT-76()/GGC and shelter. The AN/VSC-2 normally is authorized in airborne and airmobile units. For further details, see TM 11-5815-331-14.

182. Radio Terminal Set AN/TRC-80 and AN/TRC-80A

a. Radio terminal set AN/TRC-80 () (fig. 68) uses the principle of tropospheric scatter communication and is a component of the pershing missile system. The AN/TRC-80 () antenna is highly directional and must be map oriented. The AN/TRC-80() is immune to all known electronic

countermeasures to a higher degree than other conventional radio equipment.

b. The characteristics of radio terminal set AN/TRC-80 () are as follows:

- (1) Range:
 - (a) *Nondiversity operation*: 100 kilometers.
 - (b) *Diversity operation*: 160 kilometers
- (2) *Operational reliability*: 99.9 percent.
- (3) *Approximate weight*: 4,800 pounds.
- (4) *Communication capability*: Voice and teletype.
- (5) *Frequency*: From 4,400 to 5,000 megahertz (superhigh frequency (SHF)).
- (6) *Channels*: AN/TRC-80 333 at 1.8 megahertz intervals. AN/TRC-80A 12,000 channels at 50 kilohertz intervals.)

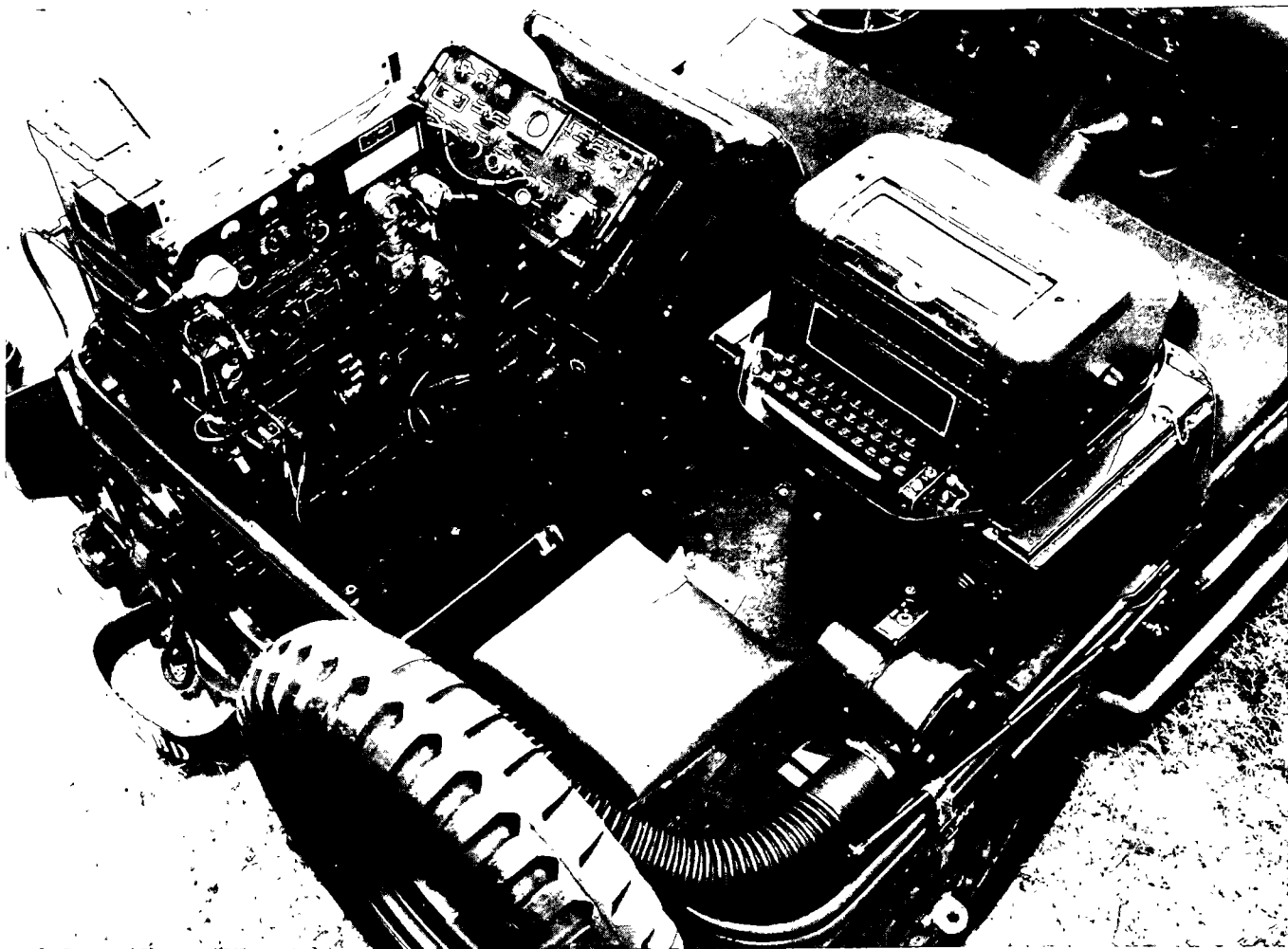


Figure 67. Radio teletypewriter set AN/VSC-2.

(7) *Type of modulation*: Frequency modulation.

(8) *Power output*: 1000 watts.

(9) *Beam width*: 35 mils (about 2°).

c. The characteristics of the power plant are as follows:

(1) *Type*: Gasoline-engine-driven alternator.

(2) *Rating*: 10 kilowatts.

(3) *Voltage*: 208/120 volts, 3-phase.

(4) *Hertz*: 400.

183. Tropospheric Scatter Radio Communication

When the Pershing missile system was developed, a suitable long-range communication system was designed simultaneously. This system uses the tropospheric scatter principle of radio communication.

a. *Principle of Tropospheric Scatter*. Radio energy waves, especially at high frequencies, bend

back toward the earth. This is called beam refraction and is the result of continuous changes in velocity of radio propagation. Such velocity changes are the direct result of adjacent air masses of different temperature, density, and humidity characteristics and of impurities, moisture, and dust particles in the troposphere. These unstable characteristics exist mainly in the troposphere, which comprises approximately the first 10,000 meters of the atmospheric layer above the earth. In order to stay within the tropospheric and also to obtain more favorable angles of incidence of the radio energy waves, the AN/TRC-80 radio set operates at a low angle of elevation (fig. 69 and 70). The algebraic sum of the antenna elevation angles on a TRC-80 radio circuit cannot exceed 0° if the 99.9 percent reliability is to be maintained at the rated range of the set.

b. *Description of Radio Set AN/TRC-80 ()*. Radio set AN/TRC-80 () consists of one transmitter and two receivers. The antenna is an air-

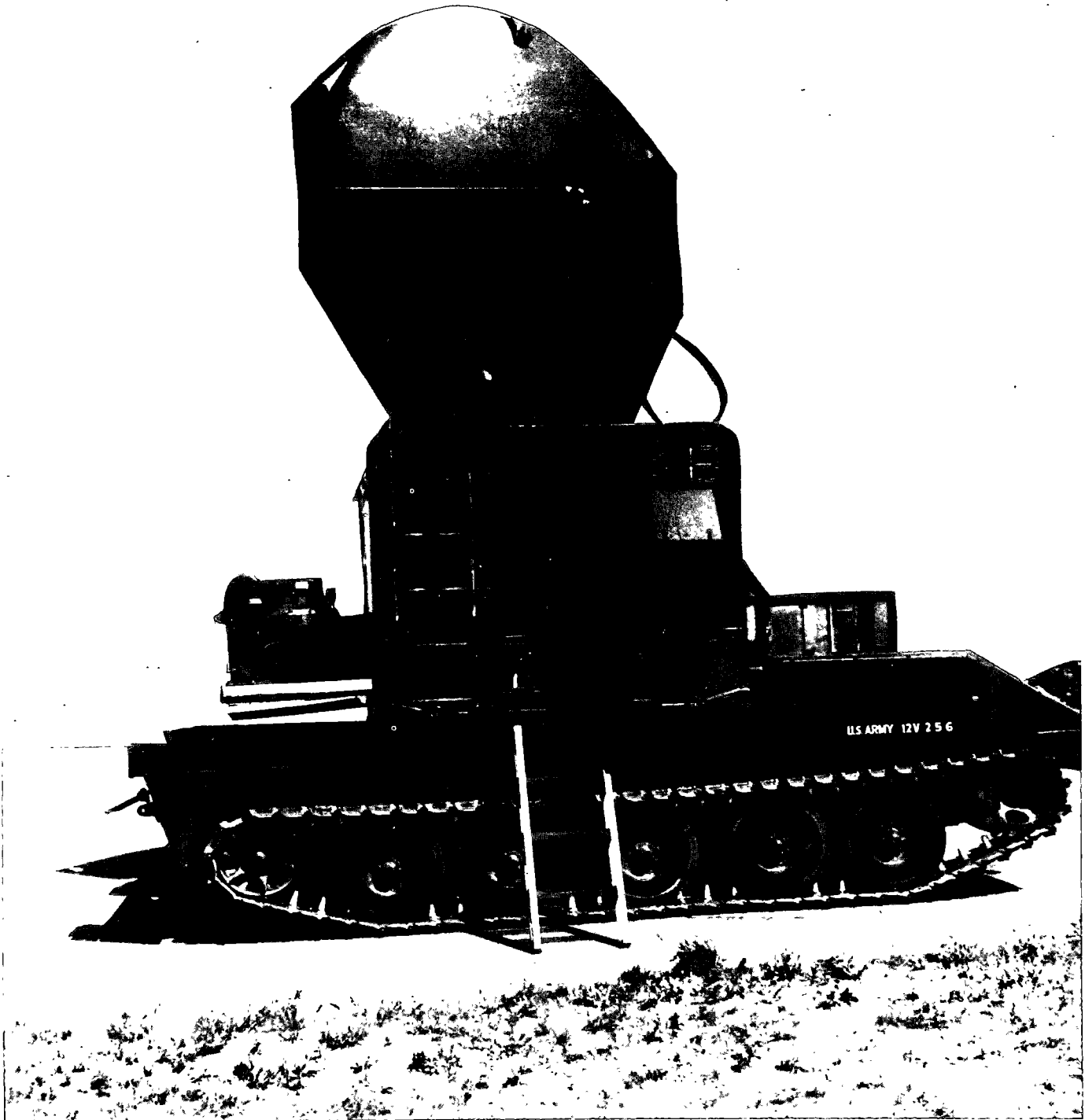


Figure 68. Radio terminal set AN/TRC-80 () and tracked vehicle M 474.

inflatable parabolic reflector with a polarized feedhorn assembly at the focal point of the 8-foot parabolic antenna. The set provides 333 or 12,000 channels and operates in the superhigh-frequency spectrum between 4,400 and 5,000 megahertz. At that frequency, a wavelength is about 6 centimeters (about 2 inches). The polarized feedhorn assembly allows simultaneous receiving and transmitting.

Only a very small part of the initial energy is useful energy at the distant receiver, but the receivers of this system are many times more sensitive than ordinary radio receivers. Operating sites must be selected to provide elevation angles of zero degrees or less. Each AN/TRC-80 () radio section must be furnished orienting azimuth and minimum horizon angle for its position. These

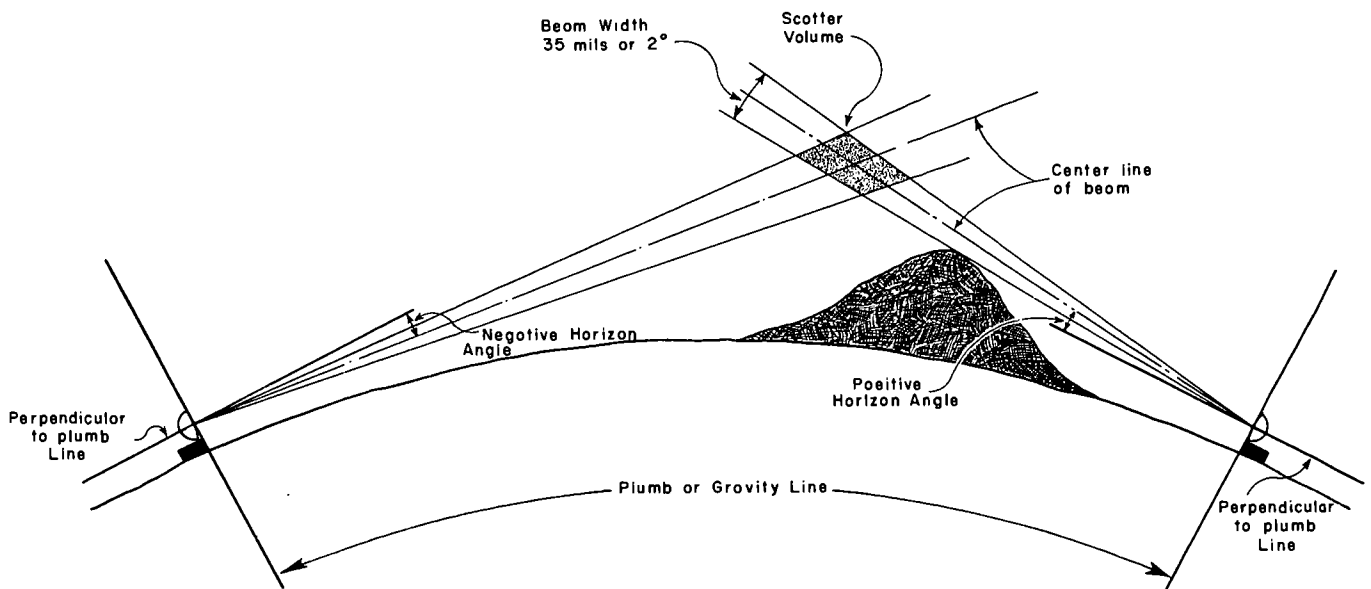


Figure 69. Geometry of tropospheric scatter principle (exaggerated scale).

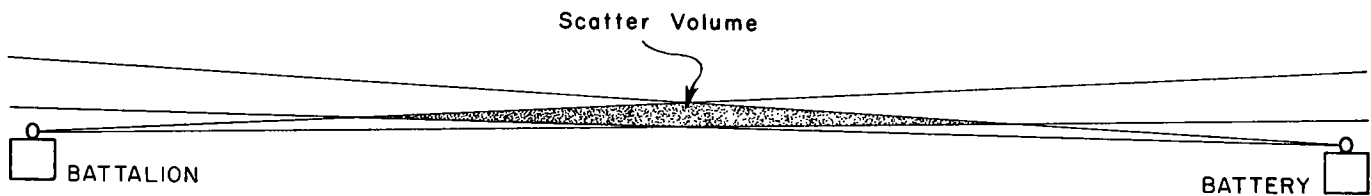


Figure 70. Geometry of tropospheric scatter principle (approximate scale).

data can be determined with a map and M2 compass. However, survey data, if available, are better.

c. Nondiversity Operation. If the distance between the battalion and a battery is 110 kilometers or less, one AN/TRC-80 () at the battery and one AN/TRC-80 at the battalion can maintain radio communication with a reliability factor of 99.9 percent (fig. 71). In this case, only two frequencies are required and only one of the two receivers at each set is used.

d. Dual Diversity Operation. If the distance between the battalion and a battery is in excess of 110 kilometers, up to about 160 kilometers, dual-diversity operation is required to maintain 99.9 percent circuit reliability (fig. 72). At the battery, both receivers are required. At the battalion, two AN/TRC-80 () radio sets are coupled together by two cables, 35 feet in length, and only portions of the receiver of each AN/TRC-20 () are used. The two AN/TRC-80 () radios function as a single battalion terminal, and the radios are called a control set and a slave set. When a message is sent from the battery, the antennas of the battalion slave and control sets receive the signal at

different locations. The signal from the slave set is connected by a coaxial cable to the control set, where it is combined with the signal received by the control set. The net result is an improved audio signal in the control set. When a message is sent from the battalion terminal to a distant battery, it is sent from the antenna of the control set on one frequency and from the slave set on a different frequency. Therefore, the receivers in the battery terminal receive the same information on two different frequencies over two separate paths. The two signals received are combined automatically in the battery terminal, and the result is an improved audio signal. The operating range is increased by 50 kilometers with no loss in the 99.9 percent circuit reliability by this method of dual-diversity operation—space diversity at battalion and frequency diversity at battery. The effects of the short-term fade cycle are reduced by using dual-diversity operation, since the message travels over two different paths through space and therefore is affected differently on each path.

e. Tropospheric Scatter Communication System. The entire tropospheric scatter communication system is shown in figure 73. One AN/TRC-80

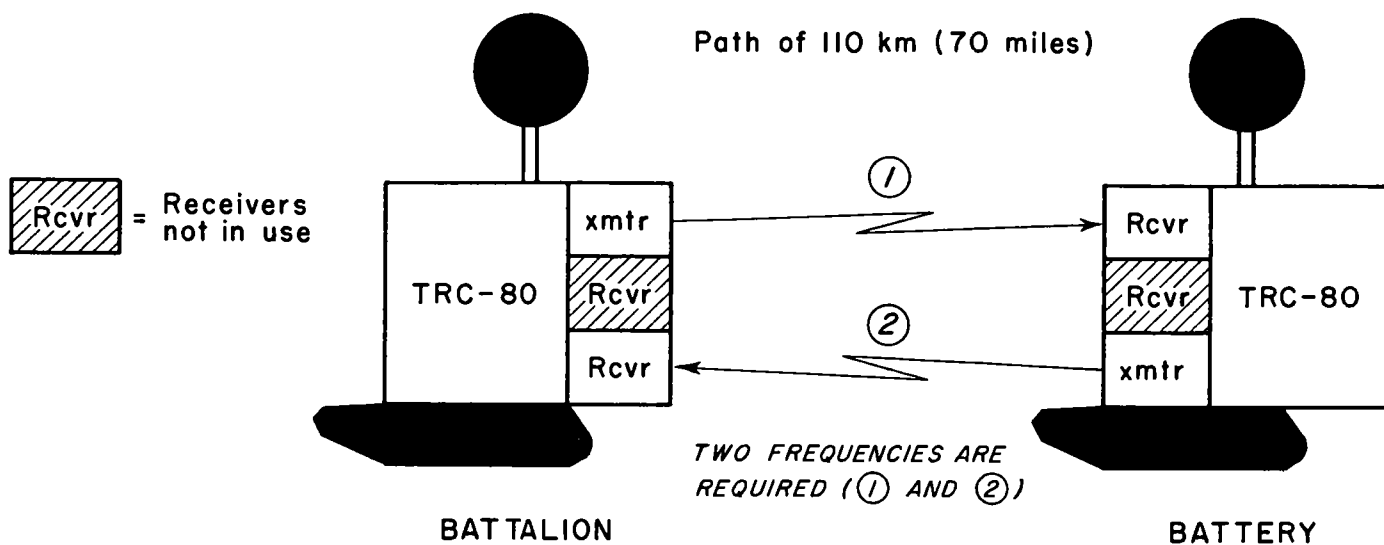


Figure 71. Nondiversity operation of the AN/TRC-80 () radio set.

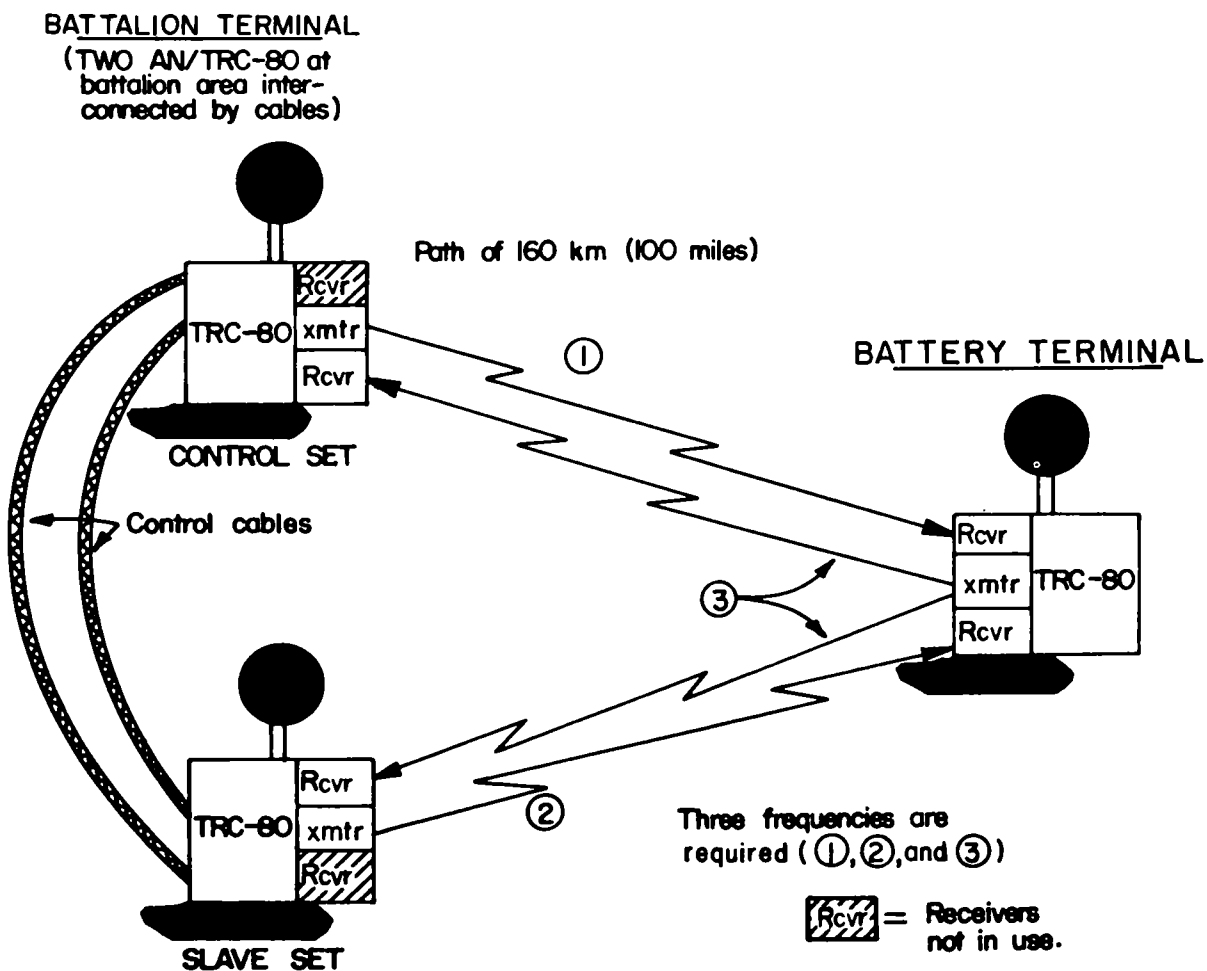


Figure 72. Dual-diversity operation of the AN/TRC-80 () radio set.

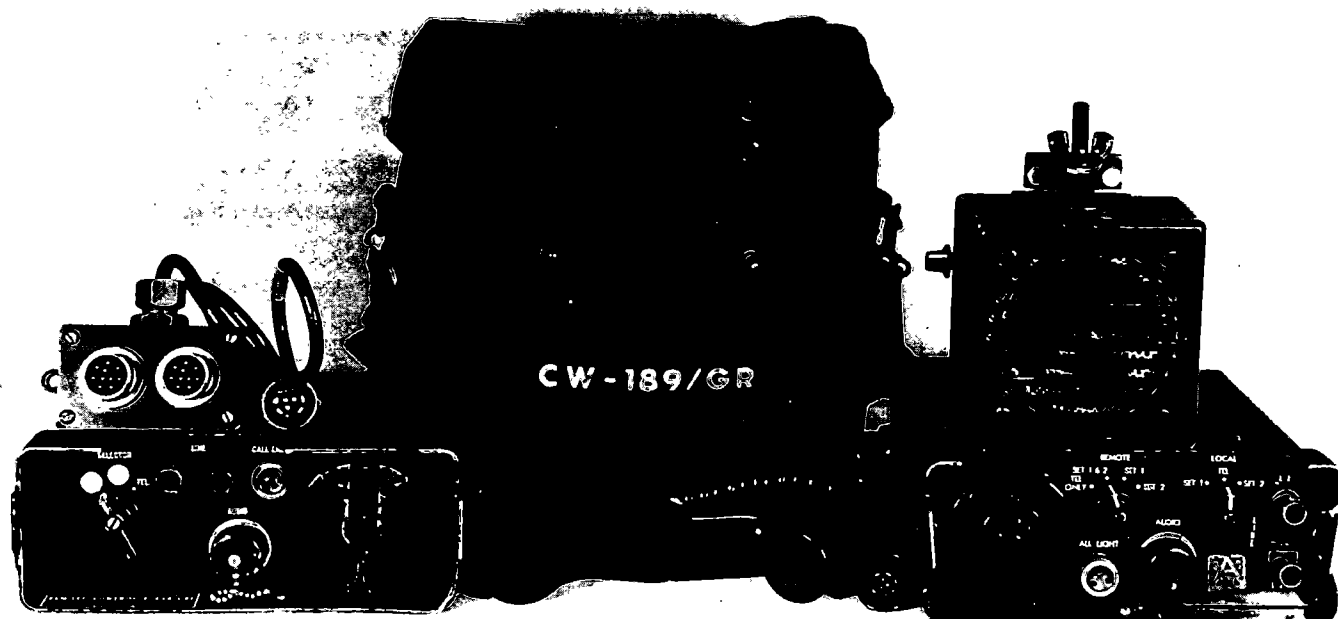


Figure 74. Control group AN/GRA-6.

(3) Remote push-to-talk operation (AN/PRC-9, AN/VRC-9, AN/VRC-17, and AN/VRQ-2).

(4) Remote power control (AN/VRQ-2 and AN/PRC-9).

c. For additional information, see TM 11-5038.

185. Radio Set Control AN/GRA-39

a. Radio set control AN/GRA-39 (fig. 75) is used with radio sets AN/VRC-12, AN/VRC-43 through -49, AN/PRC-25, AN/VRC-53, AN/GRC-125, and other similar tactical radio sets. The AN/GRA-39 allows voice transmission or reception through a radio set from a distance up to 3 kilometers. Voice transmission or reception through a radio set is established from either remote control unit C-2328/GRA-39 or local control unit C-2329/GRA-39 at the option of the operator. Provision is also made for voice communication between the local and remote operators.

b. The characteristics of the remote control and local control units of radio set control AN/GRA-39 are as follows:

(1) *Radio set control C-2328/GRA-39 (remote control unit):*

(a) *Number of transistors:* Seven.

(b) *Control distance (max):* 3 kilometers.

(c) *Operating voltage:* From 9.0 to 6.6 volts direct current.

(d) *Power supply:* Six batteries BA-30 for each unit.

(e) *Battery life expectancy:* 24 hours.

(f) *Tone generator frequency:* 3,900 hertz.

(2) *Radio set control C-2329/GRA-39 (local control unit):*

(a) *Number of transistors:* Seven.

(b) *Operating voltage:* From 9.0 to 6.6 volts direct current.

(c) *Power supply:* Six batteries BA-30.

(d) *Battery life expectancy:* 72 hours.

c. Radio set control AN/GRA-39 can be used for the following types of operation:

(1) Telephone communication between the remote and local control operators.

(2) Radio set transmission and reception from the remote control unit.

(3) Radio set transmission and reception from the local control unit.

d. For additional information, see TM 11-5820-477-12.

186. Radio Set Control AN-GSA-7

Radio set control AN/GSA-7 (fig. 76) is a small, lightweight electronic switching device for use in integrating radio and wire systems. It is also used

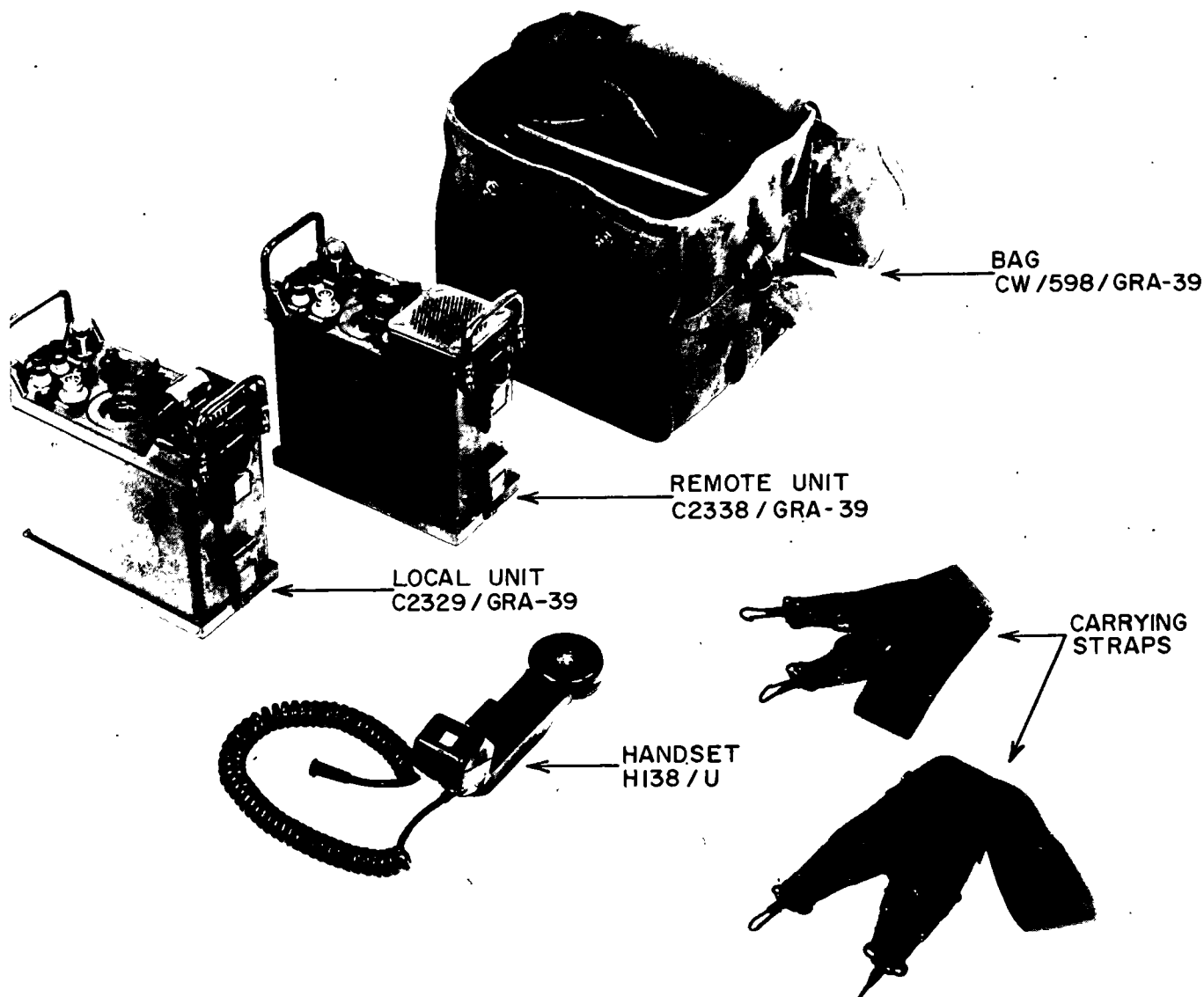


Figure 75. Radio set control AN/GRA-39.

to interconnect radio transceivers or transmitters and receivers with local-battery telephone equipment on a push-to-talk basis. Connecting with a common battery circuit will cause the set to key. Two radio set controls can be used to interconnect two push-to-talk radio sets for retransmission (automatic relay). These controls permit the operator to listen or talk to both ends of the circuit or to signal in either direction. The equipment can be operated from the ground or from a stationary vehicle. Typical systems using the AN/GSA-7 are shown in figure 78. Cable CX-7474/U must be used to make the AN/GSA-7 compatible with the VRC-12 series of radios. This cable interconnects the 10-pin cable connector of the AN/GSA-7 and 5-pin cable connectors of the new family of radio sets.

187. Radio Test Set AN/VRM-1

Radio test set AN/VRM-1 is a compact, lightweight, waterproof test set designed specifically for testing the plug-in modules of the R-442/VRC RT-246/VRC, and RT-524/VRC (AN/VRC-12 equipments). The equipment is designed on a simple "GO" and "NO GO" basis—a glowing green light indicates a serviceable module; a glowing red light, a defective module. The equipment is intended for issue to organizational maintenance personnel. For further details on the AN/VRM-1, see TM 11-6625-496-12.

188. Radio Test Set AN/GRC-55 (Electronic Circuit Plug-In Unit)

Radio test set AN/GRC-55 is a compact, lightweight, waterproof instrument, designed to make

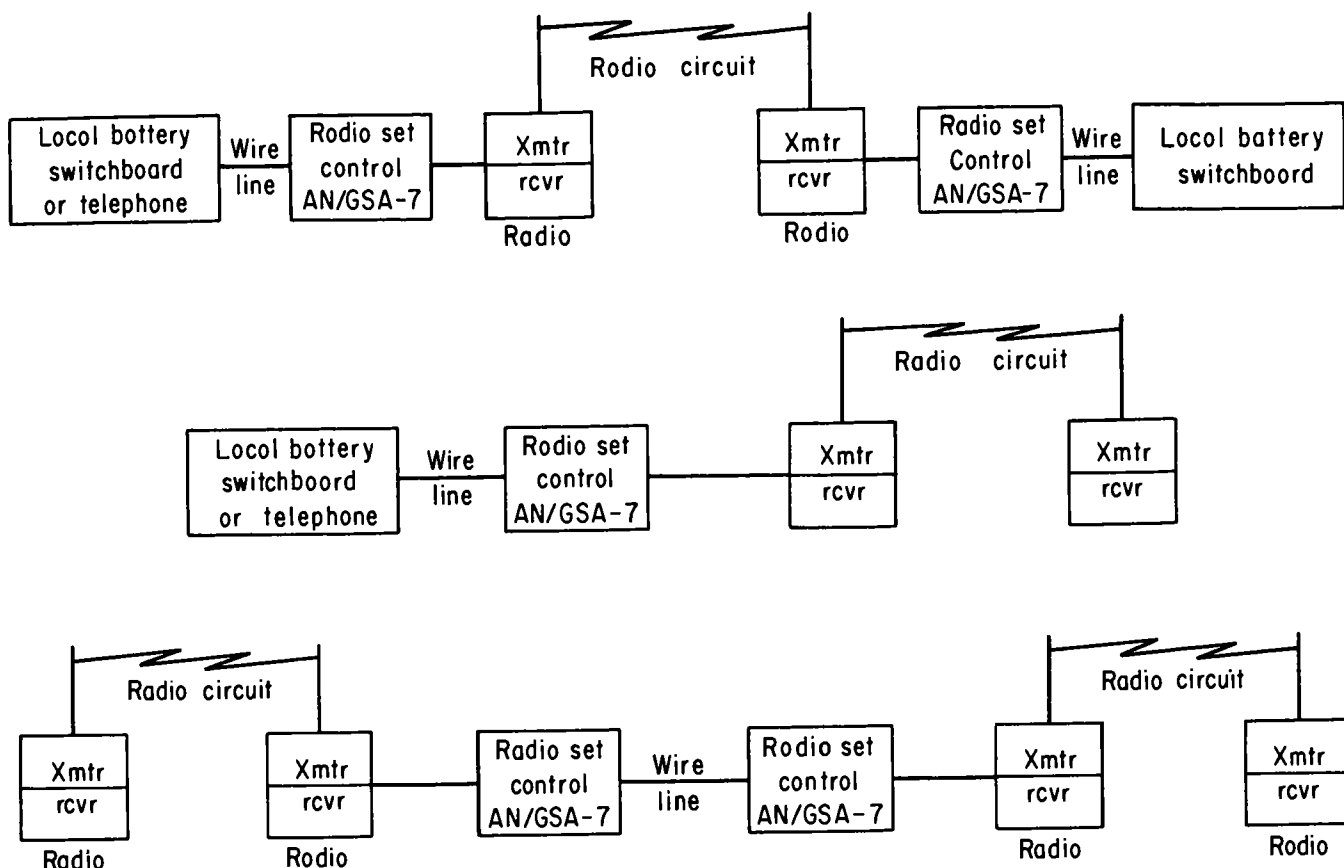


Figure 77. System application of radio set control AN/GSA-7.

tests at all available test points of receiver-transmitter RT-505/PRC-25 and to isolate a failure to a particular module. This test set cannot be used for the AN/PRC-77 configurations, since the basic unit is the RT-841 not the RT-505. The AN/GRC-55 is issued for use by radio mechanics at battalion level. For further details, see TM 11-6625-514-12. No special test set for the AN/PRC-77 is contemplated.

189. Antenna Group RC-292

Antenna group RC-292 (fig. 78) is a modified ground plane antenna designed to increase the transmission range of FM radio sets from 50 to 200 percent when operating over a frequency

range of 20 to 76 megahertz. The sections of the supporting base raise the antenna 30 feet above the surface of the ground, increasing the line-of-sight distance to the horizon. The vertical element above the mast base is the antenna. The three ground plane elements are installed at a 142° angle to the antenna to act as the counterpoise. The antenna group is connected to the radio set by a 68-foot coaxial cable. This equipment provides a radiation pattern that is omnidirectional in the horizontal plane. The length of the antenna and ground plane elements must be preadjusted to the desired frequency range, as shown in chart I, because the frequency range varies with the number of antenna sections used.

Chart I. Antenna and Ground Plane Elements

Radio set or receiver-transmitter	Operating frequency (MHz)	Number of antenna sections required	Antenna sections used				Number of plane sections required	Ground plane sections used			
			AB-21/GR	AB-22/GR	AB-23/GR	AB-24/GR		AB-21/GR	AB-22/GR	AB-23/GR	AB-24/GR
RT-66/GRC AN/PRC-8	20 to 27.9	6	3	1	1	1	18	3	1	0	1
RT-67/GRC AN/PRC-9	27 to 38.9	4	1	1	1	1	15	2	1	1	1
RT-68/GRC AN/PRC-10	38 to 54.4	3	0	1	1	1	12	1	1	1	1
RT-246/VRC, RT-524/ VRC, and RT-505/ PRC-25	30 to 36.5	4	1	1	1	1	15	2	1	1	1
	36.5 to 50.5	3	0	1	1	1	12	1	1	1	1
	50.5 to 75.95	2	0	1	0	1	9	0	1	1	1

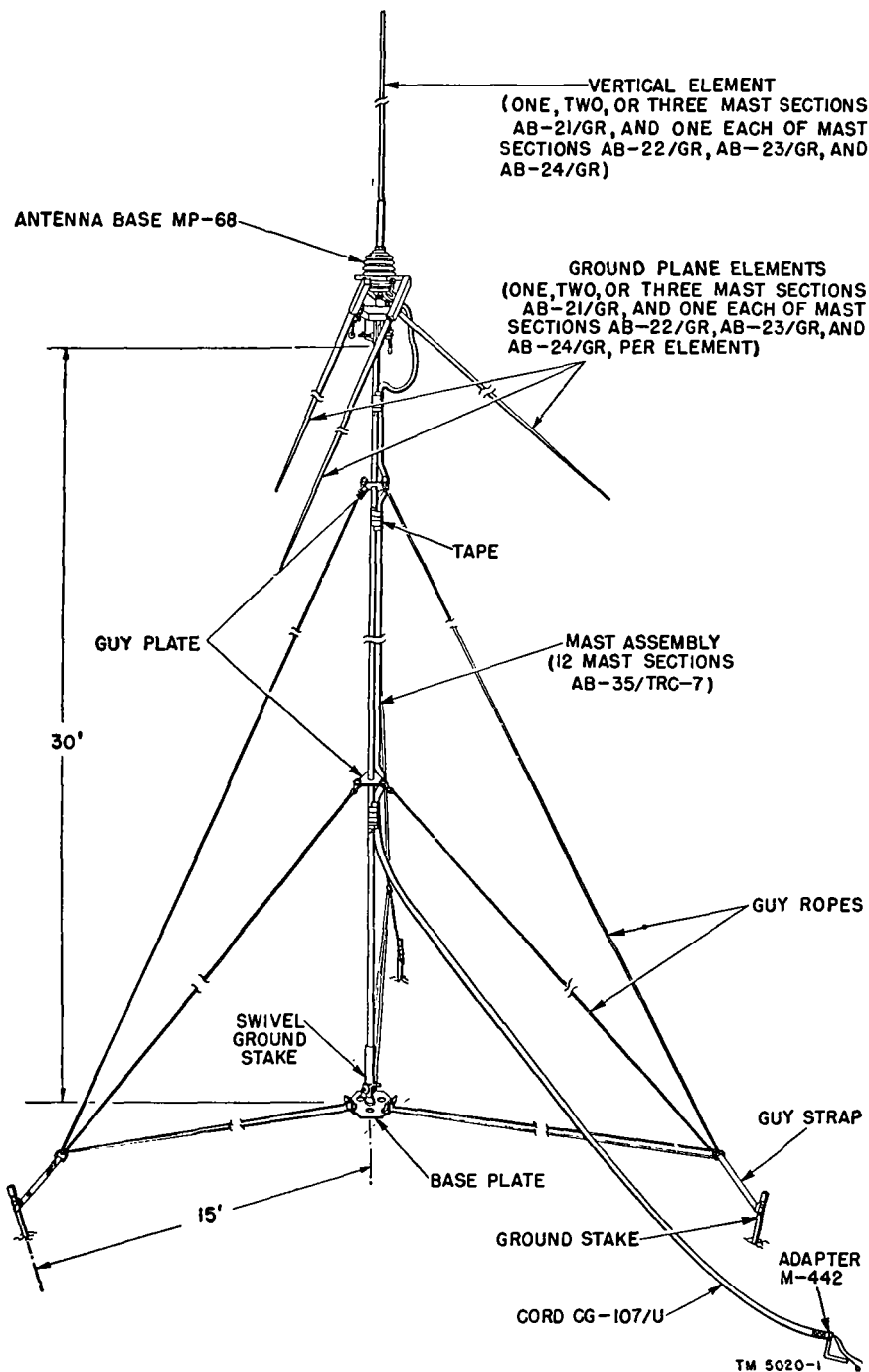


Figure 78. Antenna group RC-292.

CHAPTER 15

FIELD EXPEDIENTS

Section I. GENERAL

190. Causes of Poor Communication

Poor radio communication or lack of radio communication can be due not only to excessive distance or unfavorable terrain but to a variety of reasons. It is imperative that communication personnel understand the application of field expedients for maintaining radio communication. When available, antenna group RC-292 should be used to increase the range of, or to obtain better communication with FM radios. If the equipment is in good condition and is operated properly, other causes of poor communication or lack of communication must be considered. For example,

- a. Too great a distance between sets.
- b. Bad terrain—hills and mountains.
- c. Poor choice of location at one or both ends of the circuit.
- d. Insufficient battery power.
- e. Noise and interference.

191. Operating Hints

a. The following operating hints are useful in obtaining good communication:

(1) Use a headset instead of a loudspeaker when the signal is weak. This will cut out local noise.

(2) Be sure the microphone or handset is in good condition. Allow a few seconds for the transmitter tubes to warm up after pressing the press-

to-talk switch; then speak directly into the microphone. Speak slowly and distinctly.

(3) If the set is in a vehicle, be sure the battery voltage is normal. Keep the engine running to charge the battery.

(4) Moving the antenna a few feet to a new location may improve reception.

(5) Use CW in place of voice for increased range on AM radios.

(6) Do not start a vehicle when the radio is on.

b. When a grounded quarter-wave whip antenna is mounted on a vehicle, the metal of the vehicle will affect the operation of the antenna. As a result, the direction in which the vehicle is facing may also affect the transmission and reception of signals, particularly distant or weak signals. A radio with a whip antenna mounted on the left rear of the vehicle will transmit its strongest signal in a line running from the antenna through the right front of the vehicle. The solid arrows in figure 79 show the direction of transmission. In some cases, the best direction can often be determined by driving the vehicle in a small circle until the best position is located. The best direction for receiving from a distant station is also the best direction for transmitting to that station.

Note. The AN/VRC-12 series of radio sets use a center-fed, half-wave antenna (AT-912/VRC or AS-1729/VRC). The mass of the vehicle will not appreciably affect the radiation pattern.

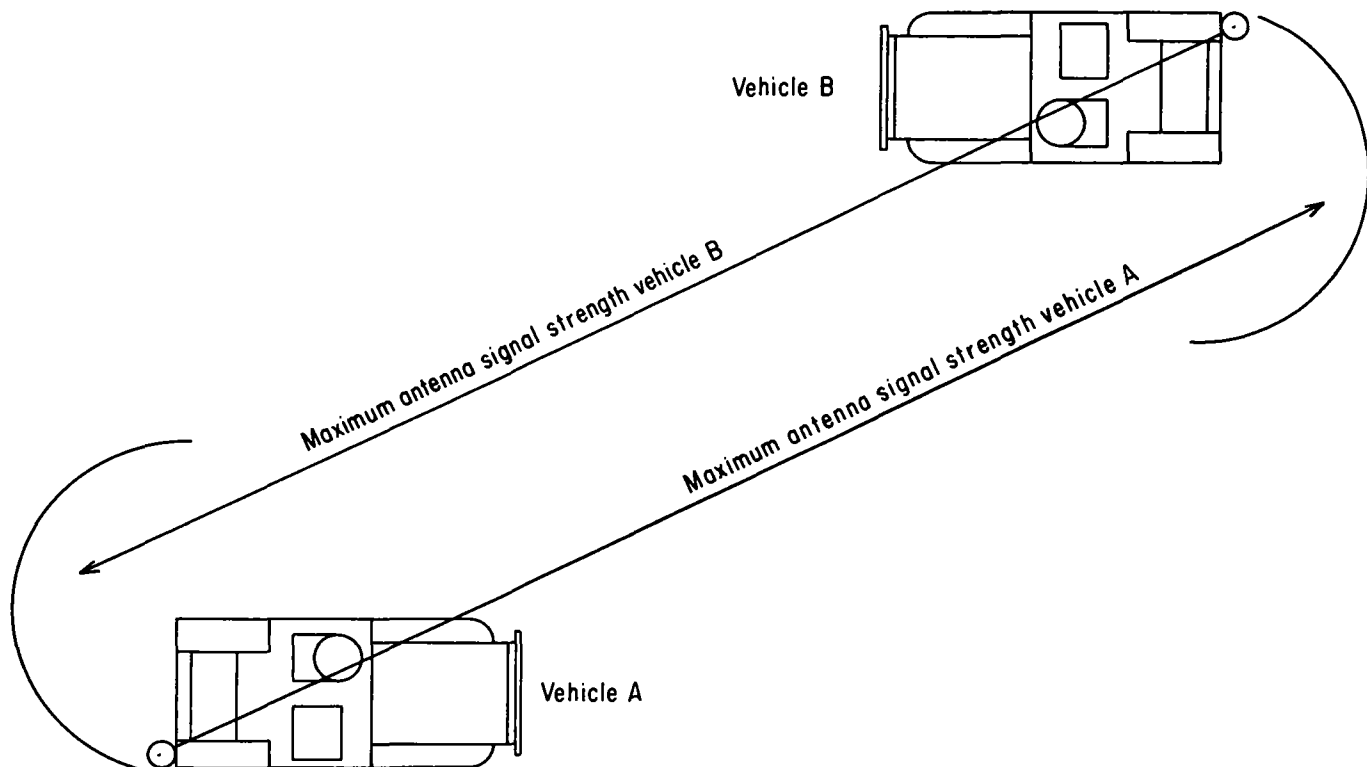


Figure 79. Best directivity of whip antenna mounted on vehicle.

Section II. IMPROVISED ANTENNAS

192. Vertical Antennas

Practically all the radio sets in the combat areas use whip antennas. This is the type of antenna that commonly is used with sets mounted in vehicles and with manpack sets that operate in motion. More detailed information on antennas can be found in the manual pertinent to the set being used and in FM 24-18. Whip antennas may be broken in use. When replacements are not immediately available, it is possible to improvise a satisfactory antenna by using telephone cable WD-1/TT (fig. 80) or by lashing together the broken pieces (fig. 81).

193. Horizontal Antennas

When the situation does not require mobility and antenna group RC-292 is not available, greater distance may be obtained by the use of horizontal antennas. Figures 82 and 85 show the construction of two types of horizontal antennas that will greatly extend the transmission range of a radio set. Note, however, that a drastic reduction in received signal strength results when the antennas of a radio circuit (except a skywave circuit) are not of the same polarization.

a. Wave Antenna Without Resistor and Ground.

The most practical antenna for antijamming use in a tactical unit is the field expedient long-wire antenna. Maximum radiation is off the ends of the antenna, and it tends to reject or reduce signals received from other directions. The long-wire antenna must be a minimum of 3 wavelengths long (100 to 150 feet) and should be made of telephone cable WD-1/TT. One end of the directional long-wire antenna is connected directly to the antenna receptacle on the receiver-transmitter, and the other end is pointed toward the station with which communication is desired.

b. Wave Antenna with Resistor and Ground.

(1) The wave antenna (fig. 82) is a long wire antenna that is highly directional. The physical length of this or any antenna is computed by using the formula $L = \frac{468}{F \text{ (MHz)}}$ where L represents the length in feet, 468 is a constant and F represents the operating frequency in megahertz.

(a) As an example, if you are operating on 24 megahertz and you desire to construct a wave antenna $2\frac{1}{2}$ wavelengths long, you compute the half-wavelength as follows:

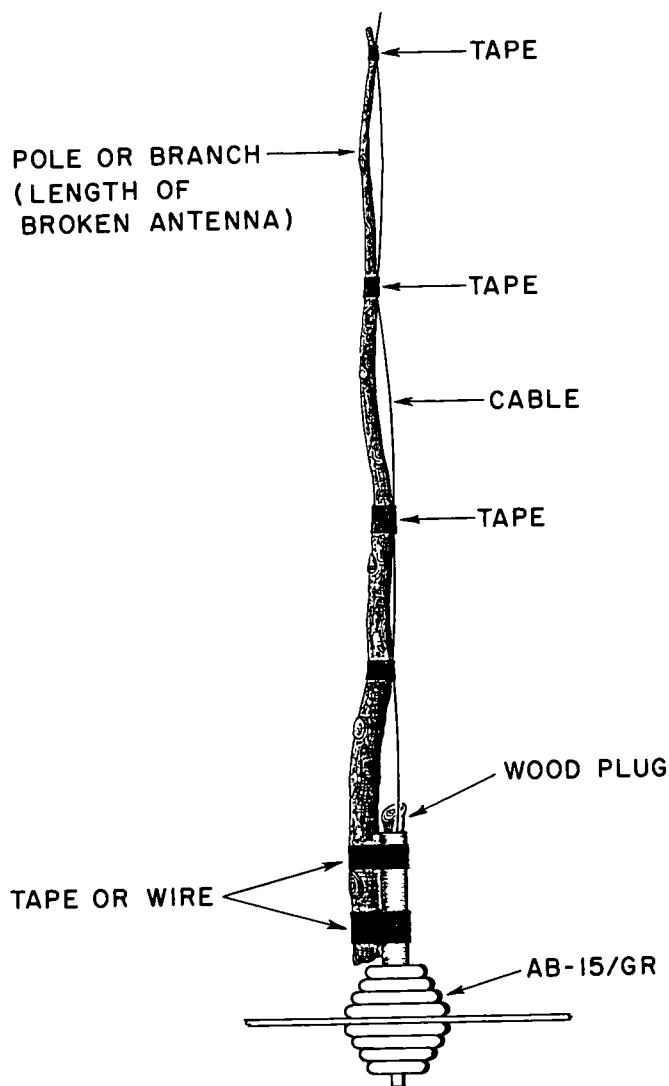


Figure 80. Emergency repair of whip antenna using telephone cable WD-1/TT.

$$L = \frac{468}{F \text{ (MHz)}}, \text{ or } L = \frac{468}{24}, \text{ or } L = 19.5 \text{ feet.}$$

(b) If 19.5 feet represents a half-wave-length, a full wavelength (one wavelength) is equal to 39 feet (twice the length of the half-wave-length). Multiply 39 feet by $2\frac{1}{2}$ for the actual length of the $2\frac{1}{2}$ -wavelength antenna. The actual length is 97.5 feet. As the antenna length is increased from the half-wave-length, the antenna becomes more undirectional. This is illustrated in figure 84. The lobes represent the direction of transmission.

(2) A suspended antenna causes considerable pull on the radio set at the connection. Difficulty may be experienced in keeping the antenna connected to the binding post. To overcome the difficulty, remove the regular whip antenna from the mounting base. Place in the mounting base a broken stub. Drill a hole through the broken stub,

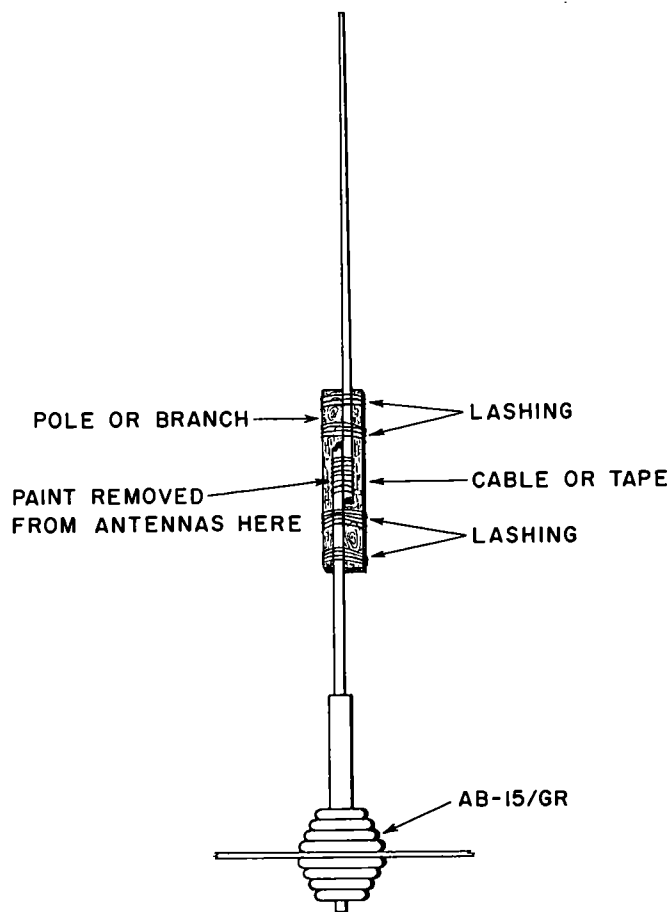
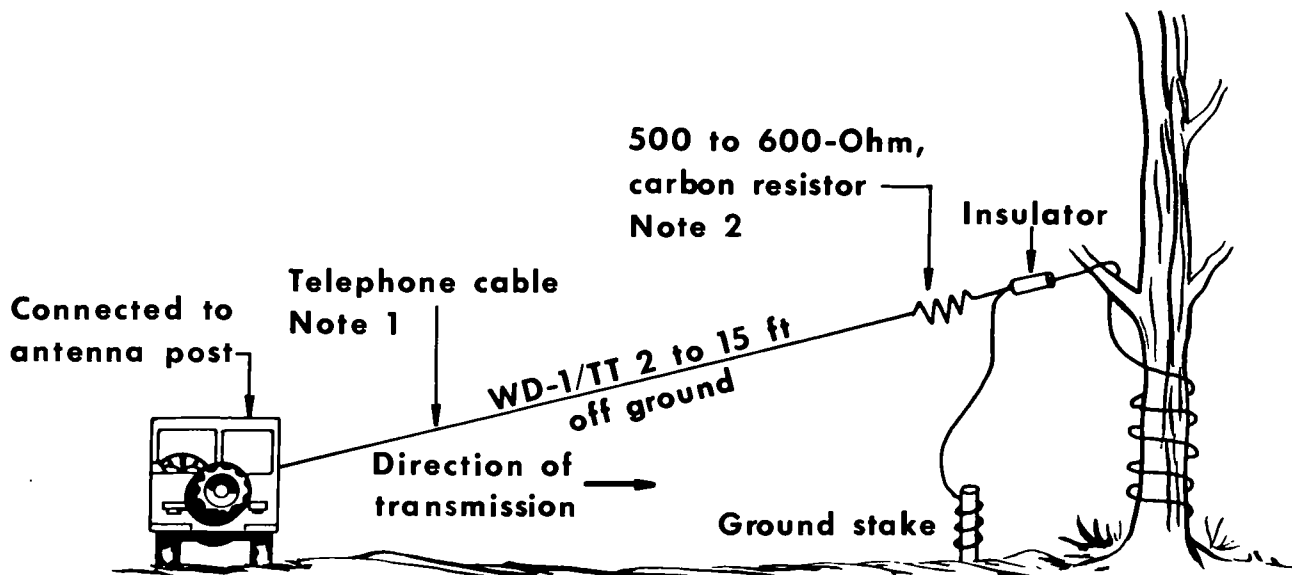


Figure 81. Emergency repair of whip antenna using broken antenna sections.

push the end of the antenna through the hole, and tie the antenna to the stub. The connection to the radio set is already on the stub. This expedient will keep the weight of the wire from pulling the wire away from the binding post. Be sure to remove the paint from the area on the stub where the antenna is connected (fig. 83).

c. *Center-Fed Hertz (Doublet) Antenna.* The center-fed Hertz (doublet) antenna is a half-wave antenna consisting of two quarter-waves, one on each side of the center insulator. The antenna is suspended in the air at a height of 10 to 50 feet. For ideal use, the antenna should be suspended as close to one-half wavelength above ground as possible. The formula for computing the physical length of this antenna is the same as that for computing the physical length the wave antenna. Bring the twisted pair of lead-in wires to the front panel of the radio set. Strip approximately one-half inch of insulation from each end of the wire. Bring one lead to the 50-ohm terminal and insert it into the small center connection of the connector. Push the spring-loaded guard back to



Formula for length of Half Wave
 Length (in feet) 468
 Frequency (in MHz)

Note 1: This antenna is preferably two or more wave lengths long.

Note 2: Capable of handling one half of the transmitter output power.

Figure 82. Wave antenna for use with AM and FM radios.

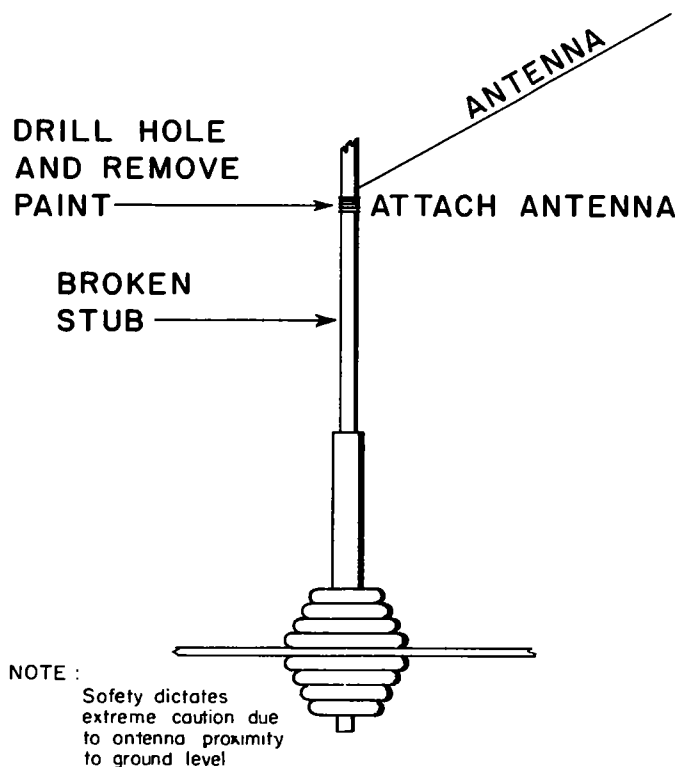


Figure 83. Expedient method of connecting a wave antenna.

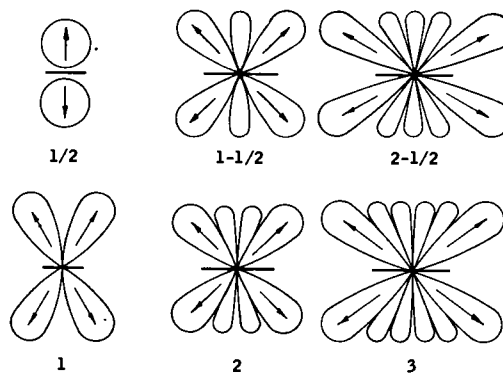


Figure 84. Radiation patterns from one-half wavelength to 3 wavelengths.

the left and secure it out of the way with a block of wood or by other means. The lead must make contact with the "hot," or center, connection and not be allowed to touch the outside shell. Ground the other lead by loosening any screw on the front panel, scraping paint from under screwhead, inserting the wire behind the screw, and tightening the screw. This antenna radiates on both sides, broadside to its length (fig. 84—half-wave), and will greatly increase the transmission planning range of the radio set.

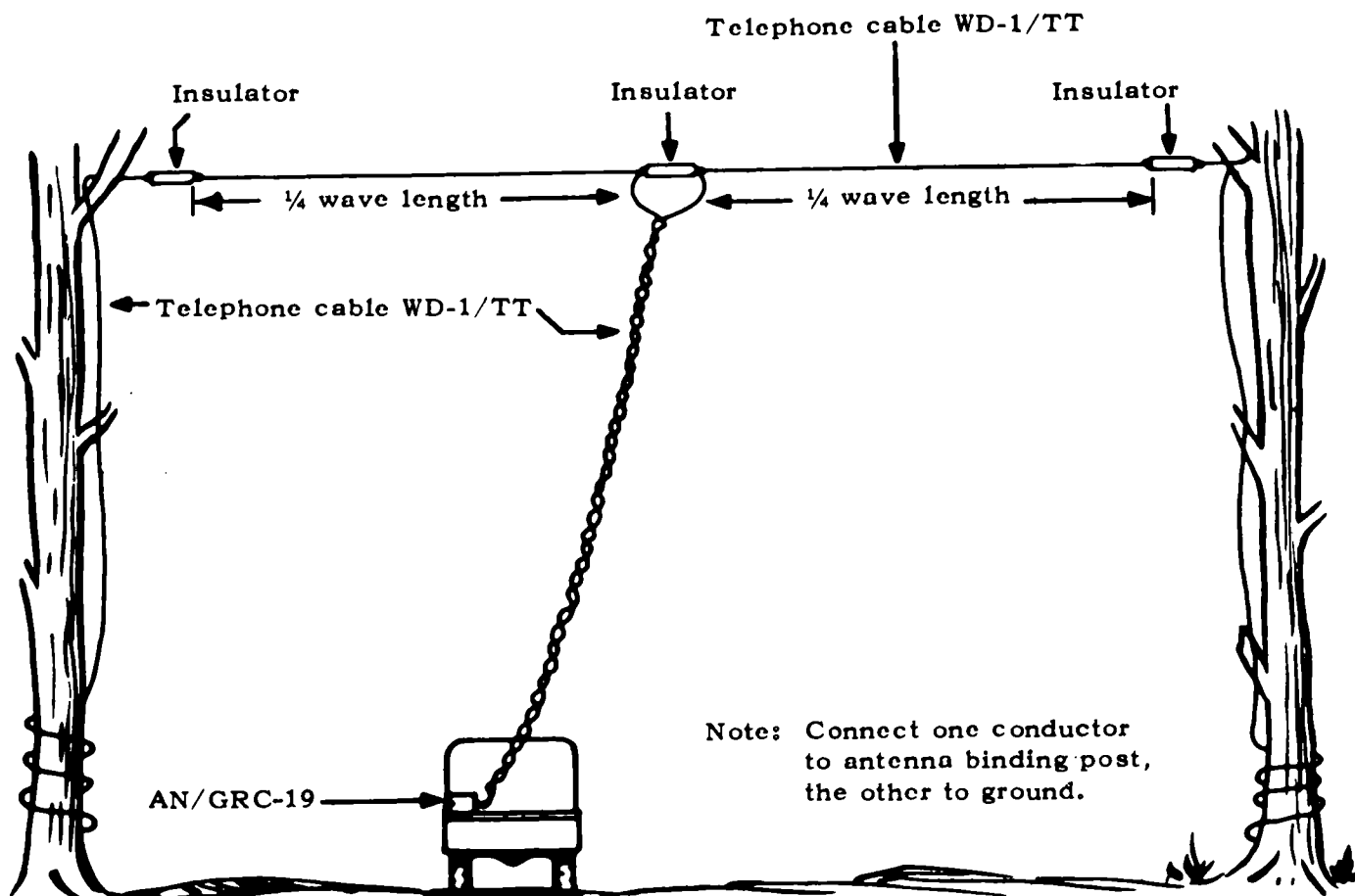


Figure 85. Center-fed Hertz (doublet) antenna for use with AM and FM radios.

194. Elevated Antennas

a. General. An elevated antenna (fig. 86) can be constructed from materials readily available in any combat unit. The standard vehicular antenna complete with bracket and mast base may be raised on poles to a desired height; the antenna may be connected to the radio set with standard telephone cable WD-1/TT. The guy wires, with insulators properly installed, can be used as the ground plane or counterpoise. This antenna, properly constructed, provides a radiation pattern which is omnidirectional in the horizontal plane.

b. Vertical Half-Rhombic Antenna. The vertical half-rhombic antenna (fig. 87) is more efficient than a whip antenna and is also directional off the terminated end. The gain of this antenna increases with size. When the limiting factor in the size of the antenna is available mast height, a leg length is used as indicated in the formula $L = \frac{H^2 f}{222} + \frac{56}{f}$ where f is the frequency in megahertz, H is the mast height in meters, and L is the leg length in meters. The example in figure 87 is solved for a mast height of 10 meters and a frequency of 30 megahertz.

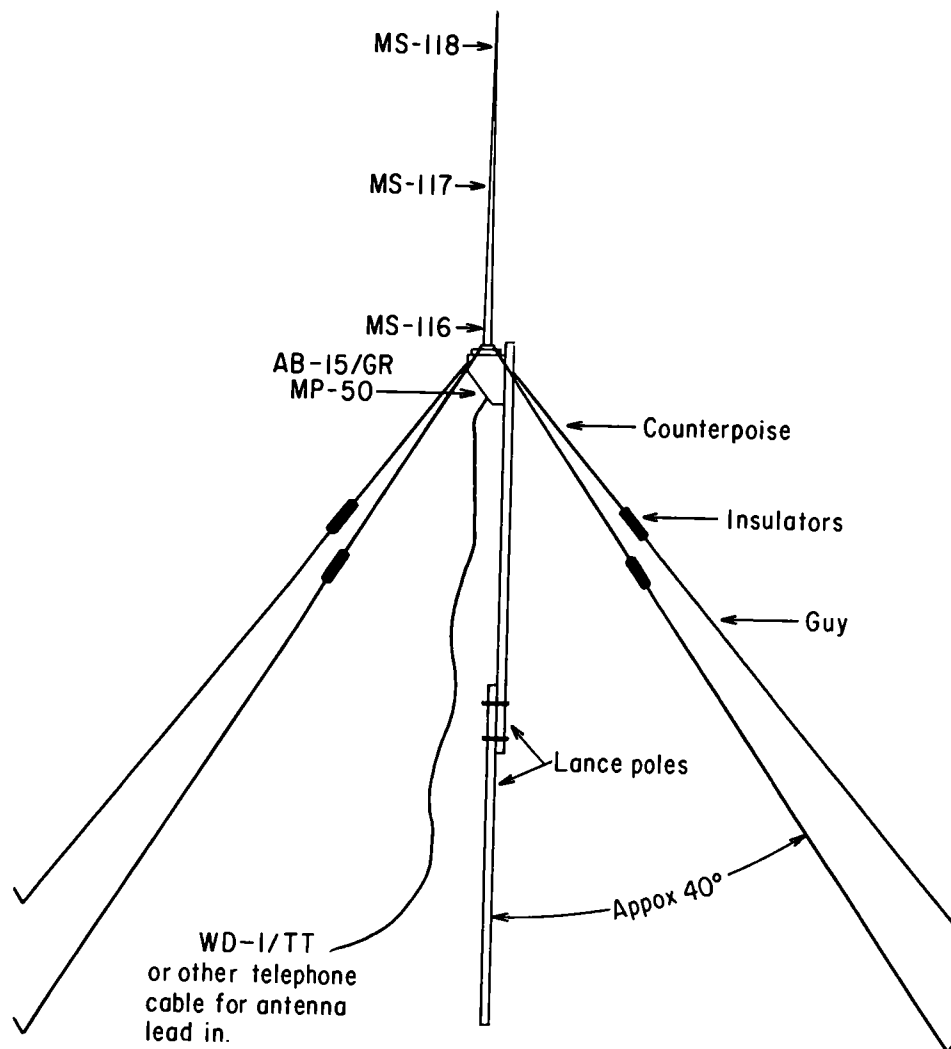


Figure 86. Improvised elevated antenna.

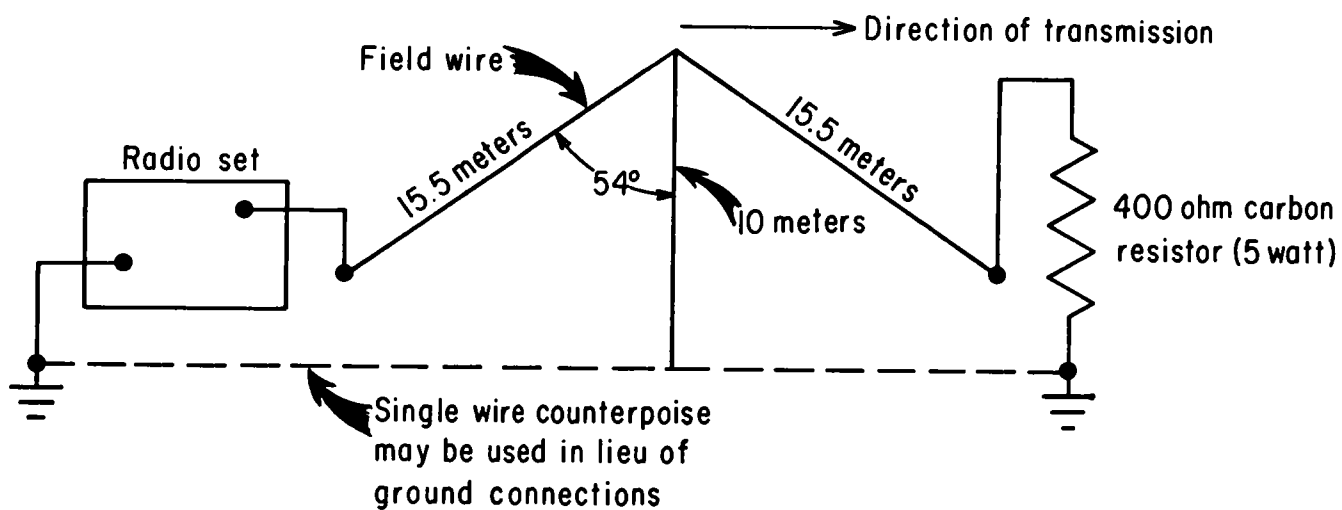


Figure 87. Vertical half-rhombic antenna.

CHAPTER 16

RADIO JAMMING AND COUNTERMEASURES

195. Definitions

a. *Jamming*—The introduction of radiation into electronic receiving equipment in order to obscure or obliterate the information that would normally be received by the equipment operators. The disrupting effects sought are achieved by tactics designed to surprise, confuse, and mislead.

b. *Electronic Countermeasures (ECM)*—The term utilized to encompass jamming and other special techniques.

c. *Antijamming (aj)*—Tactics, techniques, and procedures designed and employed to reduce the effectiveness of electronic jamming attacks.

196. Radio Jamming

a. All radio equipment is vulnerable to jamming. It must be assumed that the enemy will employ jamming signals whenever jamming is advantageous to him. Radio jamming should be expected, and antijamming measures should be planned in advance. A transmitter that is specifically designed for jamming or any transmitter that can be tuned to the proper frequency may be used for jamming.

b. The two basic types of radio jamming are—

(1) *Spot jamming*—enemy transmission of a narrow-band signal on a specific frequency or channel.

(2) *Barrage jamming*—Simultaneous interference on a wide band of frequencies or adjacent channels.

c. It is assumed that the enemy is constantly striving to devise new and more confusing forms of jamming signals. Any signal may be used, but some are more effective than others. Identification of the signal being used may be useful to higher headquarters in determining the jamming source. The signals are classified as modulated or continuous wave. Some of the more common jamming signals are explained in (1) through (8) below.

(1) *Spark*—A simple, easily produced jamming signal that is most effective. The signal con-

sists of numerous bursts of noise of short duration, high intensity, and high repetition rate, normally much louder or higher in level than the desired signal. The noise is similar to that which an electric razor produces in some broadcast receivers. Because of the broadband characteristic of the signal, a number of channels can be covered by one jammer using this type of signal.

(2) *Sweepthrough*—A signal caused by sweeping or moving a carrier back and forth across a frequency band at a rapid rate. The resulting sound resembles that of a conventional aircraft engine. This type of signal is effective over a broad band of frequencies. With a high-speed sweep, the signal is effective against all types of voice modulated transmissions.

(3) *Stepped tones or bagpipes*—A signal usually consisting of three or five separate audio tones repeated over and over again. The audible effect is like the sound of a Scottish bagpipe and has a demoralizing effect on voice operators. This signal is usually employed against single-channel voice nets.

(4) *Noise (random or resistance)*—A signal that is random both in amplitude and frequency with no periodically recurring frequency. This signal cannot be filtered out or otherwise eliminated without also removing the desired signal. It produces a sound similar to the rushing noise heard in an FM receiver when squelch is off, volume is maximum, and no signal is being received. It is especially dangerous, since the operator may mistake the signal for normal receiver or atmospheric noise and fail to take antijamming action. Noise is regarded as one of the better types of jamming modulation and is effective against all types of radio transmissions.

(5) *Random-keyed, modulated continuous wave*—A signal consisting of a continuous wave keyed at random and modulated. It may be used in airdropped expendable jammers against voice channels, since it is easy and cheap to generate.

(6) *Rotary*—A signal produced by a low-pitched, slowly varying audio frequency, pro-

ducing a grunting sound and used against voice modulated transmissions.

(7) *Miscellaneous signals*—Some other signals which are used as jamming signals for their nuisance value only are gull, pulse, tone, and wobbler.

(8) *Voice jamming*—Any transmission made by voice, such as singing, talking, chattering, or whistling.

197. Deception by an Enemy

a. Deception by an enemy is the subtle use of countermeasures and is closely related to enemy jamming. Deception may be introduced into a radio net by an enemy station posing as a friendly station.

b. Deception usually is intended as a nuisance but may be used by an enemy to gain tactical or communication intelligence. Deceptive techniques include transmitting false tactical instructions in clear text or requesting that various types of classified information be transmitted in the clear.

198. Recognition or Detection of Jamming

a. If interference is present, the antenna should be disconnected from the receiver or the antenna should be grounded to determine the source of the interference. If there is no change in the receiver noise level after these actions are taken, the receiver is probably at fault. However, if the noise level drops, the source is outside the receiver and it may be jamming or it may be accidental interference.

b. Accidental interference may be a radio communications signal (transmitted by friendly force or even by enemy forces) or it may be a broad band interfering signal emanating from power lines or rotating electrical equipment.

c. Barrage jamming is difficult to distinguish from broad-band accidental interference. Each usually spreads over all or most of the tuning range of the receiver. However, the range of non-communications accidental interference is relatively short, and a search of the immediate area may disclose the source. The possibility of accidental interference should be eliminated before a disturbance is reported as jamming. Unidentifiable interfering signals should be reported immediately to the next higher headquarters.

199. Reporting Jamming

a. An enemy jamming attack usually is part of a well-organized plan and frequently precedes im-

portant tactical maneuvers. Properly correlated jamming information can be a warning and may provide intelligence of possible enemy action.

b. Jamming information to be reported, in order of importance, is as follows:

(1) Frequency or channel being jammed, including width of the jamming signal, if known.

(2) Type of jamming signal.

(3) Time and duration of jamming including any repetition.

(4) Signal strength and effect on radio communications, including effect on other stations in the net. Signal strength should be classified as strong, medium, or weak.

(5) Unit, name, and rank of operator making the report.

c. The detailed report should be made by the operator to the commander and should be processed through channels to higher headquarters.

200. Operating Procedures

During jamming attacks, continue attempts to transmit the message and to confuse the enemy jammer as to his effectiveness. The following procedures will lessen the effects of, and assist in working through, enemy jamming:

a. *Precautionary Measures.*

(1) Radio and antenna siting and antenna orientation are important. Locate the antenna so that hill formations, buildings, or other natural screens and obstructions are between it and the enemy. Utilize a very high frequency. Use remote control equipment to site the radio set in the most advantageous position.

(2) Utilize the directional characteristics of a long-wire antenna or another type of directional antenna. Orient the antenna toward the specific station or stations with which you must communicate. Also, utilize the directional characteristics of a half-wave horizontal antenna by orienting the null of the antenna (the direction of the antenna wire) toward the jamming station.

(3) Transmit only when absolutely necessary. Use only the amount of radiated power necessary to communicate.

(4) Use proper operating signals and brevity codes. Use station and message authentication to prevent deception. Do not engage the enemy in conversation.

(5) Adjust speed of transmission to particular circumstances. However, *do not* suddenly reduce speed during a jamming attack, as this gives the enemy an indication that the jamming is effective. Your deceptive tactics may discourage

him from continued or further jamming efforts for a particular operation.

(6) Do not cease operation during a jamming attack even if the signal is blanketed. Continued operation keeps the enemy jammer engaged and gives him no indication of his effectiveness.

b. Receiver Control Techniques.

(1) Tune carefully to the incoming signal rather than to a dial mark.

(2) Adjust the volume control for the best signal-to-jamming ratio.

(3) Use the frequency change system. Switch to an alternate frequency in accordance with some prior arrangement. Change call signs simultaneously with frequency change. Do not expect or expect receipt for a message except by an alternate means of communication. Use only authorized alternate frequencies.

201. Antijamming Instructions

The enemy can jam all radio circuits and stations. To reduce the effectiveness of jamming attacks, personnel should take the actions specified in *a* through *c* below.

a. Commander and Staff Officers. The commander and staff officers should—

(1) Reduce the use of radio to the absolute minimum.

(2) Preplan all operations when possible and use brevity codes to effect plans and directives.

(3) Keep messages as short as possible.

(4) Stress radio discipline and security.

(5) Destroy enemy jamming stations when possible.

(6) Always inform the next higher headquarters of jamming.

b. Communication Officers. Communication officers should—

(1) Use radio only when necessary.

(2) Train radio operators to readjust equipment and to continue operation through jamming.

(3) Enforce radio discipline and security to the maximum.

(4) Require authentication of all transmissions.

(5) Site radio stations and antennas to evade enemy jamming.

(6) Always include alternate call signs and frequencies in signal operation instructions (SOI) and include prearranged plans for their use.

(7) Always report jamming to the commanding officer and staff.

c. Radio Operators. Each radio operator should—

(1) Site the station and antenna to evade enemy jamming.

(2) Learn to recognize enemy jamming and report details to the officer in charge.

(3) Learn to readjust his set to minimize the effect of jamming.

(4) Learn to copy and operate through jamming.

(5) Operate with minimum power until jammed and then increase the power.

(6) Shift to alternate frequencies and call signs as directed.

(7) Authenticate all transmissions.

(8) Keep off the air as much as possible and transmit only when necessary.

CHAPTER 17

MAINTENANCE MANAGEMENT PROCEDURES

Section I. THE ARMY MAINTENANCE SYSTEM

202. Principles of Maintenance

Preventive maintenance is everyone's job. However, there are different degrees and types of responsibilities and functions. An effective maintenance system depends on a realistic approach to the duties of every member of the preventive maintenance team. Webster defines the word "maintain" as to keep in a certain condition, especially in a state of efficiency. Army maintenance comprises all actions taken to retain materiel in a serviceable condition, to include inspecting, testing, servicing, repairing, rebuilding, and reclaiming. Maintenance is performed in accordance with published maintenance doctrine at the authorized level, consistent with the tactical mission, time available, personnel, and facilities. A unit with a mission to fight cannot spend time rebuilding communications/electronics equipment. Such a unit must have the technical support of a higher maintenance activity which does not have a direct combat mission.

203. Categories of Maintenance

a. General. Maintenance operations are assigned to specific levels of command in accordance with the primary mission, characteristics, and mobility of the level involved and the economical distribution of resources. All authorized maintenance within the capabilities of an organization will be performed whenever possible on economically repairable items before these items are sent to the next higher maintenance organization. Higher levels will perform the maintenance functions of lower levels when required or when directed by the appropriate commander. Unserviceable materiel the repair of which is beyond the maintenance capability of an organization will be reported or delivered to the next higher maintenance organization. Repairs will be accomplished on site when feasible and in accordance with maintenance allocation charts.

b. Maintenance Responsibilities. The overall maintenance task is divided into four general categories, as follows:

(1) *Organizational maintenance.* Organizational maintenance is that maintenance normally authorized for, performed by, and the responsibility of a using organization on the equipment in its possession. This maintenance consists of functions and repairs within the capabilities of authorized personnel skills, tools, and test equipment as prescribed in the appropriate Department of the Army table of organization and equipment. Maintenance exceeding the normal copy may be performed when authorized by the next higher maintenance support command.

(2) *Direct support maintenance.* Direct support maintenance is that maintenance normally authorized for and performed by designated maintenance activities in direct support of using organizations. This category of maintenance is limited to the repair of end items or unserviceable assemblies in support of using organizations on a return-to-user basis.

(3) *General support maintenance.* General support maintenance is that maintenance authorized for and performed by designated table of organization and equipment (TOE) and table of distribution (TD) units in support of the Army supply system. Normally, TOE and TD general support maintenance organizations will repair or overhaul materiel to required maintenance standards in a ready-to-issue condition based on applicable supported Army area supply requirements.

(4) *Depot Maintenance.* Depot maintenance activities, through the overhaul of economically repairable materiel, augment the procurement program to satisfying overall Army requirements and, when required, provide for repair of materiel when such repair is beyond the capability of general support maintenance organizations. For further details, see AR 750-5.

204. Preventive Maintenance

a. The Role of Preventive Maintenance. Preventive maintenance—the cornerstone of the entire

maintenance system—is the systematic care, inspection, and service of equipment to maintain it in a serviceable condition and to prevent breakdowns. Preventive maintenance is accomplished by the equipment operators and organizational maintenance personnel. The minor repairs and parts replacement authorized for organizational maintenance are considered preventive because they are designed to forestall the more complex and time-consuming repairs that will otherwise result.

b. Problems. The operation and maintenance of military equipment, in most cases, is complex. Thus, an unenlightened operator may cause thousands of dollars of damage and the loss of many man-hours by one incorrect action. Peacetime presents an additional problem in that it is difficult to instill in a man the fact that the lack of communication due to inoperable signal equipment can mean the complete annihilation of his unit. The fact that the equipment does not belong to the operator also presents a problem because a person's pride in maintaining his personal property is lacking when the equipment belongs to millions of taxpayers and not to him. Maintenance camouflage presents still another problem, since rust, dirt, and grease are often covered by a new coat of paint or a bearing surface is polished to a high brilliance by a rough abrasive. All of these factors and others can cause necessary preventive maintenance to be ignored or delayed until major repairs are necessary. The answer to all of these problems can be found in properly training operators and supervisors, establishing definite schedules for the performance of needed preventive maintenance services, inspecting equipment for proper functioning at prescribed intervals, and providing incentives for the proper performance of maintenance procedures.

205. Maintenance Responsibilities

a. Command responsibility. Command responsibility normally rests with the commander of a battery, battalion, division artillery, etc. Within a battery the chiefs of section and the platoon leaders are the commanders of their respective units. Instructions relative to command responsibility are equally applicable to officers and non-commissioned officers in command positions. These commanders are responsible for insuring that all equipment is serviceable and mission-ready. To do this effectively they must constantly plan, maintain records, inspect, and comply with instructions and procedures for maintenance operations. The commander should, also, bear in mind that training in preventive maintenance is equal

in importance to other functional military training. For further details see AR 750-5.

b. Supervisory Responsibility. Supervisory responsibility is a function of command and is charged to the individual of the organization, such as the chief of section, platoon leader, executive officer, or unit commander who has been entrusted with equipment for use in performing his assigned mission. The officers and noncommissioned officers within a unit are responsible for supervising the maintenance activities within their respective commands.

c. Maintenance Staff Officer Responsibility. The maintenance staff officer is appointed by the commander to supervise and report on the preventive maintenance program within the unit and to carry out other duties outlined in FM 101-5.

d. Individual Responsibility. Assigned operators or users of equipment are responsible for the proper care and operation of this equipment. They are directly responsible to insure the performance of proper preventive maintenance services and in many cases will be required to perform these services themselves.

206. Standing Operating Procedures for Maintenance

a. General. To obtain an efficient preventive maintenance program, the organization must abide by an adequate preventive maintenance standing operating procedure (SOP). Standing operating procedures reduce the number, length, and frequency of orders. The SOP establishes the regular procedure to be followed in the absence of specific instructions.

b. Scope. Each command develops appropriate and effective standing operating procedures based on applicable portions of published procedures of higher headquarters, the desires of the commander, and the habitual procedures developed through experience. The SOP is changed as necessary to meet various conditions of existing practices. The amount of detail varies with the size and state of training of the unit. Some of the general headings of the SOP are—

- (1) Responsibilities.
- (2) Personnel and training.
- (3) Organization for maintenance.
- (4) Publications and references.
- (5) Maintenance management procedures.
- (6) Requesting maintenance services.
- (7) Shop operations.
- (8) Supply procedures.
- (9) Maintenance standards.

(10) Maintenance under adverse conditions.

(11) Reports.

(12) Equipment improvement recommendations.

c. Format. Equipments assigned to units are varied and many. Although there are some general maintenance requirements which apply to all equipment, it would be most difficult to write an SOP which could be applied by all personnel to all equipment assigned to an organization. For example, the maintenance requirements for communications/electronics equipments and for mobility devices are not identical in nature. Thus, the organizational maintenance SOP normally is prepared with a basic or general requirements section and separate annexes which define the maintenance procedures to be followed by specific sections and/or individuals or which apply to specific items of equipment.

d. Separate Memorandums. Technical instructions concerning only a limited number of personnel are published in the form of separate memorandums. In each case, reference is made to the appropriate place in the body of the basic standing operating procedure.

207. The Reorganized Army Divisions

The reorganized Army divisions provide five types of divisions—infantry, armor, airborne, airmobile, and mechanized. Each reorganized division has a common base which includes three brigade headquarters, a division artillery, and a division support command. Varying numbers and types of battalions (infantry, mechanized, tank, or airborne infantry) are assigned to the division in accordance with its mission and geographic location.

208. Division Support Command

a. General. The division support command (DISCOM) is a major subordinate unit (at the same echelon as the division brigade and division artillery) which provides logistical support for the division. The support command gives the division a logistical organization with the flexibility required for support during all types of operations. The composition of the support command varies in transport, supply, and maintenance elements according to the type division it is designed to support. The division support command provides the support through three battalions—the medical battalion, the supply and transport battalion, and the maintenance battalion. (In addition, airborne has an air equipment support company and airmo-

bile has an aircraft maintenance and supply battalion.)

b. Maintenance Battalion. The maintenance battalion of the support command provides direct support maintenance for all types of maintainable division materiel except medical equipment, cryptographic equipment, electrical accounting machines, and quartermaster air equipment. It also provides repair parts for the equipment it supports, other maintenance supplies required in operations, and a maintenance float of selected end items. Although the maintenance battalion in any type of division consists of the same primary elements, each maintenance battalion is tailored to meet the demands of the division it supports. The maintenance battalion of the support command—

(1) Performs direct support maintenance on supported materiel of the division and assists in performing maintenance that is beyond the capability of the supported units.

(2) Provides technical assistance service to the division in all activities related to the tactical mission of the maintenance battalion.

(3) Obtains, stocks, and issues repair parts and maintenance supplies required for the maintenance of supported equipment.

(4) As authorized, controls and maintains the items that make up the division maintenance float.

(5) Provides limited vehicular evacuation to supported units. The recovery of unserviceable and abandoned materiel is a primary responsibility of the unit to which the materiel belongs or in whose area it is found.

(6) Operates maintenance collection points for the collection, identification, classification and proper disposition of unserviceable and abandoned materiel of a type supported by the maintenance battalion.

c. Supply and Transport Battalion. The supply and transport battalion of the support command is responsible for supplying the division and its attached units with all items of supply except class V (ammunition), medical items, cryptographic items, aircraft parts and supplies, and repair parts. The supply and transport battalion—

(1) Establishes and operates distributing points for classes I (rations), II (clothing, organizational equipment and vehicles, and repair parts), III (POL), and IV (items not otherwise classified and for which initial allowances are not prescribed by approved issue tables) supplies.

(2) Maintains reserve stocks of classes I and III supplies and selected fast-moving stocks of classes II and IV supplies.

(3) Provides transportation for administrative support operations.

(4) Provides limited transportation for tactical movements.

(5) Provides bath facilities on an area basis.

(6) Provides map supply.

(7) Establishes the graves registration collection point in the division support area.

(8) Operates a division salvage collection point.

209. Organization for Maintenance Within the Combat Battalion

a. Introduction. To solve the many signal maintenance problems within combat units, maintenance supervisors must be cognizant of the many maintenance concepts. Each supervisor should know the tools, equipment, and personnel available for performing the maintenance functions. Unlike the chiefs of battery and battalion maintenance sections which perform supervisory inspections, routine and emergency repairs, and periodic maintenance services on vehicles assigned to the battalion, commanders must rely heavily on section chiefs and operates to perform the preventive maintenance on service signal equipment. Only two radio mechanics (either MOS 31B20 or 31B30) are authorized by the table of organization and equipment for the infantry division field artillery battalion. Too often it is assumed that these two enlisted members must perform all the organizational maintenance services on the signal equipment authorized the unit. When it is considered that there are some 370 separate items of communications/electronics equipment authorized the headquarters and headquarters battery alone, it becomes apparent that this is impossible. Communications officers and communication chiefs must make the tactical decision as to the organizational services which will be performed by the operators and those which will be performed by the radio mechanics. In making his decision, the communication officer or chief must consider the state of training of the operator, the tools and repair parts authorized, and the facilities for accomplishing the assigned maintenance task. He must exercise caution in his decision to assign organizational maintenance functions to operators. The uninformed operator may do more harm than good.

b. Organizational Communications/Electronics Maintenance Personnel. Organizational Communications/Electronics maintenance personnel perform the duties listed in (1) through (8) below.

(1) *Battalion communication officer*—Directs and supervises the maintenance of the battalion communication equipment.

(2) *Assistant communication officer (communication platoon leader)*—Exercises direct supervision over the maintenance of all communication equipment issued to the headquarters and headquarters battery.

(3) *Battalion communication chief*—Supervises and coordinates, under the direction of the communication officer, all organizational maintenance activities of Communications/Electronics maintenance within the battalion. Takes personal charge of Communications/Electronics maintenance in the headquarters battery.

(4) *Battalion wire section chief*—Is responsible for the maintenance of the equipment assigned to the wire section.

(5) *Battalion radio section chief*—Is responsible for the maintenance of the equipment assigned to the radio section.

(6) *Radio mechanic*—MOS 31B20—Tests and performs organizational maintenance on field-type radio equipment. Determines the causes of breakdowns and the extent of the maintenance required. (Also maintains FADAC (Field Artillery Digital Automatic Computer) if his MOS is 31B30, since he has been trained in FADAC maintenance.)

(7) *Radio teletypewriter operators, radiotelephone operators, switchboard operators, and wiremen*—Inspect, clean, service, lubricate, make minor adjustments, and replace minor parts to maintain the equipment operated.

(8) *Battery communication chief*—Takes personal charge of the maintenance of communication equipment issued to the battery.

210. Duties of Key Communications Personnel

a. Purpose. This section is established as a guide for communications/electronics maintenance operations, management, and training within a type field artillery battalion.

b. Battalion Communications Officer. The battalion communication officer is a member of the commander's special staff. As a representative of the battalion commander, the communication officer has the following maintenance responsibilities:

(1) Directs and supervises the instructions of maintenance procedures for communications/electronics equipment assigned to the battalion.

(2) Establishes, directs, and supervises the communications/electronics maintenance program of the battalion.

(3) Keeps the battalion commander informed of the materiel readiness status of communications/electronics equipment.

(4) Recommends to unit commanders the maintenance training procedures to be followed.

(5) Establishes, directs, and supervises the organizational communications/electronics equipment maintenance schools.

(6) Assists unit commanders in conducting periodic inventories and inspections.

(7) Recommends to unit commanders the personnel to be sent to service schools.

(8) Maintains a record of service school-trained personnel and insures that available school quotas are filled.

(9) Instructs unit commanders, staff officers, and selected section chiefs on their mandatory obligations to maintain communications/electronics equipment assigned to their units and/or sections.

(10) Conducts periodic command maintenance inspections.

(11) Recommends the assignment of individuals for coordination and supervision of maintenance functions for assigned equipment.

(12) Insures that operators with dual assignments (driver-radio-telephone operator) are trained in the care and maintenance of the assigned communications/electronics equipment.

(13) Maintains contact with the direct support maintenance activity.

(14) Prepares and administers competitive examinations for selected specialists.

(15) Insures that all records and reports required by TM 38-750 are maintained on communications/electronics equipment.

(16) Coordinates closely with the battalion maintenance officer and recommends the maintenance functions to be performed on vehicular-mounted signal communications/electronics equipment during maintenance periods (motor stables).

(17) Plans the location and organization of and the procedure to be followed by the battalion signal maintenance shop.

(18) Insures that correct procedures are being followed in determining, requisitioning, accounting for and storing the prescribed load of repair parts.

(19) Establishes procedures for the evacuation and repair of all communications/electronics equipment.

(20) Insures that defective communications/electronics equipment is evacuated promptly.

(21) Prepares the signal portion of the materiel readiness status reports.

(22) Insures that all required technical publications, including changes in effect, are on hand, up to date, and available for use.

(23) Establishes procedures for the performance of periodic maintenance services within the battalion.

(24) Insures that overages/shortages of equipment, components, assemblies, repair parts, and miscellaneous expendables do not exist.

(25) Establishes procedures for the conduct of equipment serviceability criteria (ESC) evaluations.

(26) Establishes and directs the safety program for communications/electronics equipment.

c. Assistant Communication Officer (Platoon Leader). The assistant communication officer, as a headquarters battery officer, commands the battalion communication platoon. The assistant communication officer has the following maintenance responsibilities for communications/electronics equipment assigned to the communication platoon:

(1) Exercise direct supervision of the maintenance functions performed on communications/electronics equipment assigned to the headquarters battery.

(2) In the absence of the battalion communication officer, performs the duties of the battalion communication officer.

d. Battalion Communication Chief. The battalion communication chief is the principal enlisted assistant to the battalion communication officer and performs the following maintenance duties:

(1) Supervises the maintenance program as directed by the battalion communication officer.

(2) Establishes and supervises the operation of the signal maintenance shop.

(3) Plans, coordinates, and schedules the performance of periodic maintenance services.

(4) Supervises the conduct of equipment serviceability criteria evaluations.

(5) Establishes test stations for serviceability evaluations of radio sets.

(6) Maintains close liaison with battery communication chiefs.

(7) Presents instruction in maintenance management and record procedures.

(8) Collects, verifies, and transmits all equipment data collection forms.

(9) Maintains close liaison with support maintenance activities.

(10) Provides the battalion communication officer with information on materiel readiness.

(11) Insures by inspection and supervision that the maintenance records required by TM 38-750 are being maintained and that correct procedures are being followed.

(12) Supervises the preparation and maintenance of the forms and records required in determining, requisitioning, and accounting for and storing the prescribed load of repair parts (AR 735-35) for communications/electronics equipment.

(13) Establishes and maintains the unit library of organizational technical publications to support signal maintenance functions at battalion level.

(14) Coordinates closely with the support maintenance activity and insures that all defective communications/electronics equipment is promptly repaired or evacuated.

(15) Insures that radio mechanics stay within the scope of organizational maintenance functions.

(16) Enforces the rules of shop safety.

(17) Inspects repaired equipment prior to its release to the user-owner.

(18) Keeps the battalion communication officer informed as to overages and shortages of communications/electronics equipments or supplies.

(19) Periodically checks to insure that appropriate records have been posted reflecting organizational repairs and services.

e. Radio Mechanics. The assigned radio mechanics are responsible for performing the organizational repairs and services as designated by the appropriate equipment technical manual. The senior radio mechanic, in addition to performing maintenance, supervises the work of the junior radio mechanic. Radio mechanics are responsible for—

(1) The care, servicing, security, and maintenance of the tools and test equipment issued for use.

(2) Diagnosing repairs and/or adjusting equipment and/or components.

(3) Establishing and maintaining the preventive maintenance (PM) schedules and records for

all communications/electronics equipment requiring periodic services (including FADAC, when applicable).

(4) Performing periodic maintenance services on all communications/electronics equipment.

(5) Preparing maintenance requests for equipment requiring support maintenance services and/or repairs.

(6) Promptly evacuating defective communications/electronics equipment to support maintenance.

(7) Knowing the procedure for maintaining the organizational maintenance forms and records required by TM 38-750.

(8) Maintains the library of organizational maintenance technical publications.

f. Section Chiefs. Section chiefs having signal electronics equipment are responsible for—

(1) Insuring that the equipment operators are trained in the operation and maintenance of the equipment.

(2) Insuring that equipments are complete with all components and operator's repair parts (running spares).

(3) Supervising the maintenance of assigned signal equipments.

(4) Insuring that communications/electronics equipment operators are familiar with the contents of operator equipment technical manuals.

(5) Insuring that operators have the required publications necessary to support their equipments.

(6) Insuring that defective equipment is evacuated promptly to the battalion signal maintenance section.

(7) Insuring that operators are familiar with the use, preparation, and disposition of the equipment inspection and maintenance worksheet.

(8) Insuring that operators of engine-driven equipment (power generator sets) are familiar with the operational records required by TM 38-750.

(9) Coordinating with the battalion communication officer and/or communication chief for required maintenance instruction.

(10) Notifying the battalion communication officer and/or communication chief of unusual maintenance problems.

(11) Closing out all data collection forms and records and submitting them to the battalion

signal maintenance activity for verification and disposition.

(12) Knowing the purpose, use, and disposition of the historical records (log book inserts) required by TM 38-750 for assigned communications/electronics equipment.

(13) Safeguarding all maintenance records and forms.

g. Battery Communication Chief. The battery communication chief is a member of the battery commander's special staff. As a staff member he is directly responsible for the communications/electronics maintenance functions of the unit. He performs job tasks at battery level similar to the job tasks assigned the communication chief at battalion level (*d* above).

Section II. MAINTENANCE RECORDS

211. Definitions

The following definitions apply to terms used in the maintenance system:

a. Combat serviceable equipment—An item of equipment which is complete and can be used immediately at its rated capacity in accordance with serviceability standards contained in applicable Department of the Army maintenance publications.

b. Deadlined equipment—An item of equipment for which the authorization for use has been withdrawn. Inoperable equipment is deadlined, but equipment may be deadlined and still be operable.

c. Deficiency—A defect or malfunction which renders an item inoperable, resulting in an unsafe or unhealthy condition for individuals or serious damage to the item, or which causes unacceptable inaccuracy or a security violation in cryptographic equipment. Materiel on which a deficiency exists is considered inoperable.

d. Shortcoming—A defect other than a deficiency which must be corrected to increase efficiency or to make the item completely serviceable.

e. Suggested improvement—The correction of a defect which is not mandatory but which would improve the serviceability of an item.

212. Status Symbols

The mechanical and maintenance status of equipment is recorded in the appropriate blocks of the equipment logs by use of the following status symbols:

a. X condition. An X indicates that the equipment is considered unsafe for operation. The equipment will *not* be operated while this type of condition exists. The X status symbol is entered in appropriate blocks when defects or unsatisfactory conditions are found or when the maintenance work required is of such a nature that the equipment is considered unsafe for operation.

b. Circled X condition. A circled X (⊗) indicates a potentially hazardous condition. However, the equipment may be operated under specific limitations as directed by higher authority or as prescribed locally until corrective action can be accomplished.

c. Diagonal condition. A diagonal (/) indicates that a fault, though not serious, exists on the equipment or that mission-essential equipment is not fully operational. This type of condition should be corrected as soon as possible.

d. Horizontal dash condition. The horizontal dash (—) indicates that a required inspection component replacement or maintenance operational check is due but has not been accomplished. The horizontal dash could indicate a potentially dangerous condition, therefore, this type of condition should be corrected as soon as possible.

Section III. ARMY EQUIPMENT RECORD SYSTEM

213. Army Equipment Record Procedures, TM 38-750

Beginning with the equipment operator and his unit, the accurate and timely recording of maintenance data provides essential maintenance intelligence and necessary controls for each successive

level of command and supporting activities. TM 38-750 prescribes the responsibilities for the preparations, use, maintenance, and disposition of US Army equipment records. It also outlines the procedures for applying the equipment record system to Army equipment in support of effective materiel readiness.

214. Equipment Logs

a. Items Requiring Equipment Logs. Chapter 4 of TM 38-750 designates those items of equipment for which historical records must be maintained and the type of records required for each item. Historical records are those records assembled and kept in the log book binder or on a single card, DA Form 2409, (Equipment Maintenance Log) as a part of the log for specific types of equipment. The equipment listed in chapter 4 of TM 38-750 is listed by commodity, and each commodity has been assigned a two character equipment category code. Electronic equipment and communication equipment are assigned primary equipment category code J. This prefix is keyed to the Army management structure. A log book binder is not prescribed for all items; however, if a historical record is still required on a certain item, the prescribed forms may be kept in a log book binder. For example, the radio set AN/VRC-46 (category code JR) requires only DA Forms 2408-5, 2408-7 and 2408-8. All these forms for the radio sets AN/VRC-46 in an organization may be kept in one log book binder.

b. Responsibilities. The commander responsible for a particular item of equipment is equally responsible for the preservation and maintenance of

the equipment log. The log will be reconstructed only in the event of loss or damage to the extent that data entered therein are illegible. The damage, loss, or destruction of the log as a result of negligence is cause for disciplinary action.

c. Equipment Log Book Inserts. There are 17 insert record forms in the Army equipment record system. Not all records apply to any one item of equipment. Equipment log inserts are filed numerically within a plastic, three-ring binder. This binder has a convenient slot on the front and side for entering the equipment nomenclature which identifies the log book with a particular item of equipment.

d. Disposition. When used as a control device, the equipment log is on or near the equipment at all times. When it is not feasible for the equipment log to accompany the equipment during operation because of operational procedures or configuration of the equipment, the equipment log may be retained at a central location. The equipment log accompanies the equipment through all levels of maintenance and is separated from the item of equipment only if action is taken to drop accountability for the equipment as a result of combat, salvage, or disposal. If action is taken to drop accountability, the complete log is forwarded to the appropriate national maintenance point (NMP).

Section IV. SCHEDULING PERIODIC MAINTENANCE SERVICES

215. General

Preventive maintenance (PM) is a continuing process. When equipment is being used, the operator must inspect the equipment before, during, and after operation. Any indication of trouble that the operator is unable to correct must be reported by him to the organizational maintenance repair personnel. Certain services, as outlined in the appropriate technical manual for the equipment, cannot be performed by the operator because of the lack of skill and tools. These services must be performed by qualified organizational maintenance personnel, who have not only the knowledge but also the necessary tools, test equipment, and supplies. The number of organizational maintenance personnel authorized in proportion to the communication and electronic equipment author-

ized precludes servicing all equipment in 1 or 2 days. Prescribed periodic services must be scheduled to assure the commander that all equipment is receiving organizational services when due and that a sound maintenance management program is in effect.

216. Preventive Maintenance Schedule and Record, DD Form 314

The preventive Maintenance Schedule and Record, DD Form 314 provides a means for recording scheduled and performed preventive maintenance services. This form also provides a record of the time that equipment is out of service (deadlined) and the category of maintenance repairs required. The information on DD Form 314 is an aid in preparing the materiel readiness status report.

Section V. INSPECTIONS

217. Preventive Maintenance Inspections

Thorough and properly conducted inspections are essential for effective maintenance. Inspections provide the commander with an indication of the

maintenance operational efficiency of his unit and measure the proficiency of maintenance and the effectiveness of the preventive maintenance program. Inspections are a command responsibility, and the commander personally participates in the

conduct of the inspections. There are two types of command inspections—formal and informal.

a. The Formal Command Inspection. The formal command inspection involves advance notice and set procedures. Although the commander personally participates in this inspection, he is assisted by various members of his staff and by technical assistants. The special composition of the party varies with the level at which the inspection is being conducted. Each member of the inspection party should have a checklist of specific items or areas to inspect. He should make sure that his inspection is thorough, complete, and correctly recorded and that immediate corrective action is taken. The results of the inspection are then consolidated, and a report is prepared for the commander. The report of the inspection should indicate not only the deficiencies and shortcomings discovered but also any superior accomplishments of the unit. A followup inspection should be made to ascertain that deficiencies have been corrected.

b. The Informal Command Inspection. The informal command inspection is made at any opportune time or place and usually without advance notice. The commander again personally participates in the informal command inspection. This type of inspection provides the commander with first-hand information on actual day-to-day conditions of the equipment and insures the maximum maintenance operational efficiency of the unit. Inspections must be frequent enough to obtain results and yet not so frequent as to harass the troops. Prior to the conduct of any inspection, the inspector should plan what he wants to accomplish. The pattern of inspecting should not be set, for personnel will soon learn to satisfy the inspector's desires.

218. Command Maintenance Management Inspections

a. General. Command maintenance management inspections (CMMI) are designed to provide commanders (normally division or higher) with an indication of the operational maintenance efficiency of each subordinate unit and activity. They also measure the proficiency and effectiveness of organizational and higher maintenance activities of each unit and command. This evaluation is obtained through inspection of sound sample quantities of materiel to determine the physical condition of the materiel. The CMMI involves advance notice and a set procedure. However, if a unit is notified too far in advance, emphasis will be placed on maintenance just before the inspection, with a tendency to deemphasize maintenance

during the rest of the year. Four hours is considered sufficient notice for most Active Army units.

b. The Inspection Team. Inspecting personnel are formed into a team consisting of a team chief and the team members. The composition of the team is determined by the type of unit to be inspected. Separate inspectors may be assigned to each category of equipment, or one inspector may inspect more than one category of equipment, depending on the amount of equipment within the inspected unit. Inspectors must be fully qualified in the technical area in which they inspect.

c. Conduct of the Inspection. The CMMI is a comprehensive inspection of all aspects of maintenance, both maintenance operations and materiel. The inspection of maintenance operations includes an inspection of maintenance management and shop operations to insure sound maintenance practices and procedures. The inspection of materiel provides an indication of the materiel readiness of the equipment and the effectiveness of the maintenance program. The inspection of maintenance operations includes inspection of personnel performance and training, maintenance management, publications, shop operations, repair parts supply, and facilities. For the purpose of the CMMI, signal materiel is grouped into communications/electronics, telephone, teletypewriter, photographic, public address, communication security, and engine-driven equipment. The inspection of materiel consists of an inspection of a random sampling of major items of equipment. The sample must be adequate to confirm the overall materiel readiness of the inspected unit's equipment. For example, if a unit is authorized 25 telephones, the minimum sample should consist of 8 telephones selected at random. An inspection of the minimum sample does not provide a firm determination of the serviceability of the items not inspected.

d. Conclusion of the Inspection. On conclusion of the command maintenance management inspection, the inspected unit is notified of its rating. The rating, *satisfactory* or *unsatisfactory*, is derived by using a numerical scoring system in which each fault is assessed a numerical value. The inspection team commander provides the unit with a narrative report which summarizes the inspection, and the inspection worksheets are given to the inspected unit. A critique is held by the team commander as soon after the inspection as practicable. During the critique, the unit's rating is announced and the major deficiencies are discussed. On completion of the critique, the inspected unit must take action to correct all deficiencies and shortcomings which were not corrected during the inspection.

CHAPTER 18

THE ARMY SUPPLY SYSTEM

Section I. INTRODUCTION AND TERMINOLOGY

219. General

a. Our military mission requires that we be prepared to fight today as well as tomorrow. Service schools graduate thousands of technicians in many military specialty fields. Regardless of how well trained the specialist may be, he must have available the equipment and the necessary tools and repair parts to successfully accomplish the mission for which he has been trained. Our supply network is vast; thousands of personnel, both military and civilian, are employed in this military industry of procurement, stockage, and final issue to the using unit. One of the most serious handicaps to the using unit often is the inability to obtain needed equipment and repair parts. Delays are sometimes justified because something has gone wrong in higher level supply channels. But most of the delays are not justified. If you are to have the authorized equipment and adequate tools and repair parts, you must take the appropriate steps to get them.

b. The communication specialist must be aware of the supply publications authorizing the equipment and supplies for his communications equipment. He must know the purpose and use of these publications so that he may determine the correct stockage allowances and request and account for all equipment, whether the equipment is expendable or nonexpendable or a major end item, a component, or a repair part. Combat units are authorized major items of communication and electronic equipment by unit tables of organization and equipment (TOE) and are required to keep correct quantities on hand and in operating condition at all times. This applies not only to major items but also to spare parts and associated equipment. Because of the complex nature of most items of communications/electronics equipment, unit and organizational supply personnel require assistance from communication personnel to properly prepare requests for needed materiel. For these reasons, you must have a general knowledge of

supply procedures, which go hand-in-hand with a good and effective maintenance program.

220. Definitions

The terms defined in *a* through *bg* below are those terms commonly encountered in supply procedures. Complete terminology may be found in AR 310-25.

a. Accountability—Obligation of an individual officially designated for a specific activity to maintain records of item balances or dollar values or both in accordance with a prescribed system. The records show authorized debits, credits, and available balances on hand or in use.

b. Accountable officers—An individual who is required to maintain accounting, including accounting records, of property and funds of which he may or may not have physical possession.

c. Administrative support equipment—Equipment not essential to the performance of assigned operational mission tasks. Included as administrative support equipment are office machines, drinking fountains, movie projectors, public address sets, etc.

d. Advice code—A code used to transmit instructions considered by the creators of supply requests and requisitions to be essential to the desired supply action.

e. Assembly—A group of two or more physically connected or related parts that can be disassembled, such as a carburetor, a powerpack, an intermediate-frequency circuit, or an amplifier.

f. Augmentation—An increase of personnel and equipment that can be applied to a specific table of organization and equipment when required by variation of the normal function or workload.

g. Authorized stockage list—A list of all items authorized to be stocked at a specific echelon of supply.

h. Back order—That portion of requested stock which is not immediately available for issue or delivery to the requesting activity and is recorded as a commitment for future issue. The terms “due out” and “back order” are synonymous.

i. Basic issue list items—Accessories, attachments, components, and assemblies and the quantities of each that make up a major end item of equipment; and the organizational maintenance accessories, tools, supplies, spare assemblies, and repair parts that accompany the equipment. Together these items constitute the complete major end item for issue.

j. Combat-essential item—An equipment item which is required by tactical units to accomplish the mission of closing with and/or destroying the enemy force.

k. Combat-essential repair part—A functional repair part which is essential for the maintenance of a combat-essential end item or system in a state of combat readiness.

l. Component—A group of connected assemblies and parts—such as a computer, receiver, transmitter, microphone, or electrical generator—that is capable of operating independently but may be externally controlled or powered from another source.

m. Current operating allowance—The total allowance of an item authorized to be on hand by the TOE, TA or modified TOE.

n. Demand code—A mandatory entry in block 13 of the Request for Issue or Turn-in (Mechanical), DA Form 2765.

(1) The letter “R” (recurring) indicates a demand to replenish materiel.

(2) The letter “N” (nonrecurring) indicates a demand for materiel to provide for initial stockage, to meet planned programmed requirements, or to meet one-time project or maintenance requirements.

o. Direct exchange—A supply method of issuing serviceable materiel in exchange for unserviceable materiel on an immediate item-for-item basis. This is accomplished without the normal property accountability documents and with a minimum of paperwork.

p. Direct exchange items—Selected items supplies to units, organizations, and support maintenance activities on a direct exchange (item-for-item) basis.

q. Document file—A file of documents supporting transactions posted to the property book and supporting receipt and turn-in of nonexpendable items, such as components of kits and sets.

r. Document identifier code—A three-character code which identifies the basic type of action, the specific subtype of transaction, and modifying instructions (card columns 1 through 3 of DA Form 2765).

s. Document number—A 14-digit nonduplicative number constructed so as to identify the military service, requisitioner, requisition date, and serial number of the requisition in accordance with AR 735-35.

t. Document register—DA Form 2064 (Document Register for Supply Actions) is used to record supply transactions and provide document control during the processing of supply documents. It is also used as a ready reference of past transactions.

u. Due in—The quantity of materiel expected to be received under outstanding procuring and requisitioning instruments or from other sources, such as transfer, reclamation, and recovery.

v. Due out—Any portion of requisitioned stock that is not immediately available for supply and that will not be referred to a secondary source of supply for supply action but will be recorded as a commitment for future issue when stocks are available. See back order.

w. End item—A combination of components, assemblies, and/or parts that is ready for its intended use.

x. Expendable items—Those items which are consumed in use or lose their identity when used. A pencil, for example, is consumed in use. A resistor, although not consumed in use, loses its identity when it is wired into a radio set; therefore, it is considered an expendable item.

y. Federal stock number (FSN)—A two-part number assigned to each item of supply that is repetitively used, purchased, stocked, or distributed within the Federal Government. The first part of the number consists of the applicable four-digit class code number of the Federal Supply Classification (FSC). The second part consists of a series of seven numerals known as the Federal item identification number (FIIN). The FIIN is a nonsignificant number, assigned serially.

z. Force/activity designator—A Roman numeral designated by the military service which relates to the mission of the unit or activity.

aa. Fringe item—An item authorized for issue but not for stockage.

ab. Hand receipt—A signed document listing and acknowledging acceptance of responsibility for property received on loan.

ac. Hand receipt annex—A document (DA Form 2062) used to record data on basic issue list items, issued as part of a major end item and to record data relative to components of sets, chests, kits, and outfits.

ad. Hand receipt file number—A number assigned to each user accepting responsibility for equipment accounted for by the property book officer.

ae. Initial demand—A request made for the initial issue of supplies.

af. Initial issue—The provision of equipment approved for issue and not previously supplied to troops. Such initial issues include issues to new inductees and newly activated units and issues of newly standardized items.

ag. Installation property—Property issued on a temporary basis to a unit while at a specific installation.

ah. Inventory—A physical count of all items of stock located within an installation.

ai. Item identification—Consists of the minimum amount of identification data necessary to differentiate an item from all similar items (in accordance with the needs of any operating activity). It also includes reference data that are essential for proper understanding of the item, useful in supply operations, or necessary in determining the classification of the item.

aj. Issue priority designator—The numerical entry which relates to the force/activity designator of the organization/activity and the urgency of need for the item requested.

ak. Julian date—A four-digit number identifying the year and sequentially numbered day of the year. The first digit is the last digit of the current calendar year or referenced year and is followed by three digits reflecting the numbered day of the year. For leap year, increase by one for the months March through December. Example: 4 October 1968—8278.

al. Line item—Unit of work measurement in supply operations based on one line entry on a requisition, shipping order, or other related document.

am. Local purchase—The function of acquiring a decentralized item of supply from sources outside the Department of Defense.

an. Nonexpendable supplies—Articles that are not consumed in use and that ordinarily retain their original identity during use. Examples are radio sets, switchboard, test sets, and instruments.

ao. Part—An item which cannot be disassembled or is of such design that disassembly is impracticable. Examples are brackets, gears, resistors, and toggle switches.

ap. Prescribe load list (PLL)—A listing of repair parts authorized for stockage by a unit and serving the unit as a concise catalog to assist in requesting replenishments.

aq. Property book—A record book kept by a company or similar unit in which are listed the quantities and classifications of its equipment except the individual clothing and equipment of enlisted men.

ar. Property book officer—An individual designated on orders to maintain accountability for property and property book.

as. Recurring demand—Demand of a repetitive nature normally representing replacement of items consumed or worn out.

at. Repair part—Any part, assembly, or component that is required for installation in the maintenance of an end item, assembly, or component.

au. Repair parts list—A list approved by designated authorities and indicating the total quantities of repair parts, tools, and equipment necessary to maintain a specified number of end items for a definite period of time.

av. Running spare—Repair part that is packaged and shipped with an operable set of equipment in addition to the parts needed for initial operation. Running spares are provided to care for replacements as they become necessary. Examples are vacuum tubes, dry batteries, and brushes for motors and generators.

aw. Salvage—Property which has some value in excess of its basic material content but which is in such condition that it has no reasonable prospect of use for any purpose as a unit and its repair or rehabilitation for use as a unit is clearly impracticable.

ax. Scrap—Property that has no value except for its basic material content.

ay. Supplies—All items necessary to equip, maintain, and operate a military command, including food, clothing, equipment, arms, ammunition, fuel, forage, materials, and machinery of all kinds. Prior to 1 January 1968 there were five classes of supplies. The classes of supply, now approved by the Joint Chiefs of Staff (JCS) for use by the JCS, the Services, and unified/specified commands, are as follows:

(1) *Class I*—Subsistence.

(2) *Class II*—Clothing, individual equipment, tentage, organizational tool sets and tool kits, handtools, and administrative and housekeeping supplies and equipment.

(3) *Class III*—Petroleum, oils, and lubricants (POL): Petroleum fuels; lubricants; hydraulic and insulating oils; preservatives; liquid and compressed gases; bulk chemical products; coolants; deicing and antifreeze compounds, together with components and additives of such products; and coal.

(4) *Class IV*—Construction: Construction materials to include installed equipment, and all fortification/barrier materials.

(5) *Class V*—Ammunition: Ammunition of all types (including chemical, biological, radiological, and special weapons), bombs, explosive mines, fuzes, detonators, pyrotechnics, missiles, rockets, propellants, and other associated items.

(6) *Class VI*—Personal demand items (includes all Army exchange retail items).

(7) *Class VII*—Major end items: A final combination of end products which are ready for their intended use, such as tanks, launchers, mobile machine shops, and vehicles.

(8) *Class VIII*—Medical materiel, including medical-peculiar repair parts.

(9) *Class IX*—Repair parts and components (less medical peculiar repair parts): All repair parts and components, to include kits assemblies, subassemblies, repairable and nonrepairable, required for maintenance support of all equipment.

(10) *Class X*—Materiel to support nonmili-

tary programs (such as agricultural and economic development) not included in classes I through IX.

Major classification only is identified in this listing. There are subclassifications in 6 of the 10 classes of supply. For example, subclassification within classes II, VII, and IX is by materiel category.

az. Supply economy—The practice of conservation of materiel by every individual in the Armed Forces. It is developed through training and practice until it becomes habit. It includes conservation, maintenance, safeguarding, recovery, repair, and salvage of food, fuel, clothing, weapons, transport, and all other materiel.

ba. Supply point—Any point where supplies are issued in detail.

bb. Table of allowance—A table prescribing the authorization of equipment for units and activities organized under a table of distribution. It includes clothing and individual equipment, training equipment, administrative equipment for use at installations, and expendable supplies.

bc. Table of distribution—A table prescribing the organizational structure and personnel of a military unit which is required to perform a specified mission and for which there is no appropriate table of organization and equipment.

bd. Table of organization and equipment—A table which prescribes the normal mission, organizational structure, personnel, and equipment for a military unit.

be. Turn-in-slip—A form used for local turn-in of excess or serviceable property.

bf. Unit of issue—The smallest unit quantity of an item that will be requisitioned and issued. For example, each, pair, package, foot.

bg. Urgency of need designator—An alphabetic letter designating the relative urgency of need of an item. Urgency of need designators are determined by the essentiality of the materiel requisitioned to the accomplishment of the military mission assigned to the force or activity.

Section II. CHANNELS OF SUPPLY AND CATALOG SYSTEM

221. Channels of Communication and Electronic Supply Within the Division

Division supply support, including storage and distribution of classes I (rations), II (clothing, organizational equipment, and repair parts), III (POL), IV (items not otherwise classified), and V

(ammunition), is a mission of the organic division support command of the armored, infantry, airborne, airmobile, and mechanized divisions. The flow of requests for supplies and equipment and the shipment of these items follow the channels shown in figure 88.

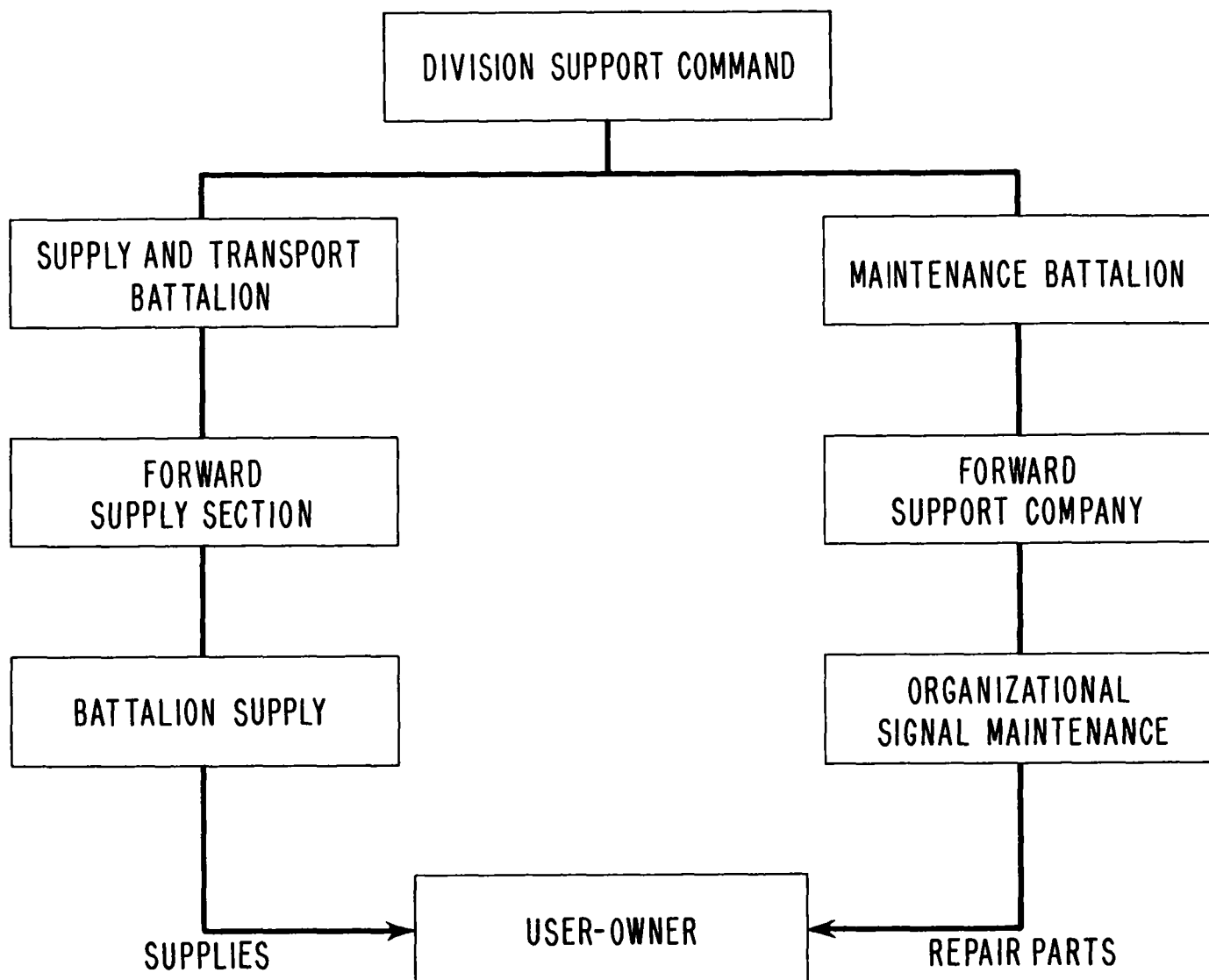


Figure 88. Channels of communication and electronic supply within the division.

222. Cataloging and Stock Numbering of Signal Equipment

a. Federal Catalog System. The Federal catalog system was the first important tool established to improve supply and permit greater efficiency in supply management operations within and among the supply systems of the Army, Navy, Air Force, and Marine Corps. The Federal Catalog System is an information-providing service for the Armed Forces. Its mission is to obtain, verify, and record, with certain item information not otherwise available and to provide management with this information. In performing this mission, the Federal catalog system—

(1) Establishes a single supply language of item identification.

(2) Provides accurate information on the identity of an item of supply.

(3) Records the source of supply items.

(4) Records the governmental activities which manage each item.

(5) Provides other item data that management may require.

b. Joint Communications-Electronics Type Designation System. Joint Communications-Electronics Type Designation (AN) System described in appendix D is designed to standardize identification of electronic materiel. Assignment of nomenclature under the AN system is a responsibility of the Joint Chiefs of Staff in accordance with the basic policies of the Office of the Assistant Secretary of Defense (Installations and Logistics).

(1) The AN system provides for the assignment of nomenclature which—

(a) Simplifies identification of electronic materiel.

(b) Is sufficiently descriptive to identify similar materiel and at the same time aid in distinguishing sufficient differences from a user's point of view.

(c) Is flexible and sufficiently broad in scope to cover present types of equipment and new types of equipment that will be developed in the future.

(d) Provides adequate identification on identification plates.

(e) Provides ready means of identifying equipment in correspondence and other means of communication in the clear.

(f) Avoid conflict with single service type designations now assigned to Air Force, Army, Marine; and Navy equipment.

(2) An AN system has been adopted by the Army, Navy, Marine Corps, and Air Force and will eventually replace individual and department systems. It is designed to cover complete sets and components but not minor parts. An example of the application of this system is the nomenclature of radio set AN/GRC-26. The nomenclature consists of an *item name* (radio set) followed by a type number (AN/GRC-26) to which a capital letter may be added to indicate a minor modification or improvement. For further details, see appendix D.

c. *Federal Supply Classification.* One of the main functions of the Federal cataloging program is the uniform classification of each item. The Federal supply classification (FSC) has been adopted by the Secretary of Defense in order to classify supply items identified under the Federal supply cataloging program. The FSC consists of 74 groups divided into approximately 500 classes. Each class includes related items and items which are usually requisitioned or issued together. The FSC uses a four-digit coding system. The first two digits identifying the group of equipment, the second two digits identify the class of equipment within the group. For example, the first two digits of the FSC code number 6130 identify the group of equipment as electrical wire, power distribution equipment and the second two digits identify the class of equipment with group 61 as rectifying equipment, electrical. The FSC code number 6135 identifies the group and class of equipment as electrical wire, power distribution equipment and batteries, primary, respectively.

d. *Federal Stock Numbers.* A Federal stock number is an 11-digit number assigned to each

item of equipment classified by the Federal Government. The first four digits identify the group and class of equipment, and the last seven digits are the federal item identification number (FIIN). For example, FSN 6135-120-1020 is broken down as follows:

61-----The FS group: electrical wire, power distribution equipment.

6135-----The FSC class: batteries, primary.

120-1020--FIIN: A number assigned serially without regard to item name, description, FSC group, or FSC class. Although this number fixes the identity of an item, it does not determine its position or sequence in relation to other items. The hyphen between the third and fourth digits of the FIIN is used for easier reading and transmission of the number. In this case, the FIIN identifies *battery BA-30*.

223. Army Supply Catalogs

a. *General.* Supply catalogs disseminate item identification and operational information required by supply and related activities. Supply catalogs include, as appropriate to the type of supply catalog, the following: Federal stock number, Federal item name and such portions of the Federal item description as necessary to identify each item adequately, unit of issue, expendability, illustrations when essential for identification, price, parts allowances and stockage guide data, cross-references, and other essential supply information.

b. *Types of Catalogs.* New types of Army supply catalogs are being prepared and will eventually supersede former types of army supply manuals. Two of the new catalogs—the identification list (IL) and the management data list (ML)—will contain the items of supply in the Federal supply classification classes which have been assigned to the Department of the Army. These two catalogs are essentially the same in content and format as those compiled by the Defense Supply Agency (DSA). Two other types of catalogs—the cross-reference list (XL) and the sets, kits, and outfits list (CL)—will be compiled according to the needs of the Army users. The catalogs contain the following information.

(1) *Identification list*—A series of catalogs containing a Federal stock number index, a Federal supply code for the manufacturer's index, a line item number index, action codes as applicable, and an identification data list which describes the items contained therein and illustrations as applicable.

(2) *Management data list*—A series of catalogs listing by Federal stock number the management data applicable to the items contained therein, such as action code, managing activity

code, price, unit of issue, supply status code, standardization code, and financial inventory accounting code.

(3) *Cross-reference list*—A series of catalogs including action codes manufacturer's code, and cross-references to applicable Federal stock numbers.

(4) *Sets, kits, and outfits components list*—A series of catalogs including action code, Federal stock number, managing activity, description, unit of issue, quantity per set, expendability, and illustrations.

224. Indexes to Supply Publications

a. *DA Pamphlet 310-1*—Index of Administrative Publications (Regulations, Circulars, Pamphlets, Posters, Joint Chiefs of Staff Publications, and General Orders).

b. *DA Pamphlet 310-2*—Index of blank forms.

c. *DA Pamphlet 310-3*—Index of Doctrinal, Training, and Organizational Publications (Field Manuals, Reserve Officers Training Corps Manuals, Training Circulars, Army Training Programs, Army Subject Schedules, Army Training Tests, Firing Tables and Trajectory Charts, Tables of Organization and Equipment, Type Tables of Distribution, and Tables of Allowances).

d. *DA Pamphlet 310-4*—Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins and Lubrication Orders.

e. *DA Pamphlet 310-6*—Index of Supply Catalogs and Supply Manuals (excluding types 7, 8, and 9).

f. *DA Pamphlet 310-7*—U.S. Army Equipment Index of Modification Work Orders.

CHAPTER 19

GUN DIRECTION COMPUTER M18 MAINTENANCE CONCEPTS

Section I. GUN DIRECTION COMPUTER M18 ORGANIZATION AND OPERATION

225. Gun Direction Computer M18 Description and Purpose

The gun direction computer M18 also referred to as the Field Artillery Digital Automatic Computer (FADAC) (fig. 89) is a transistorized, stored-program, general purpose digital computer designed primarily to compute firing data for a variety of field artillery weapons. Weighing approximately 200 pounds, the computer is readily transportable in the field. Computer M18 is issued with a field table, weighing approximately 40 pounds, which provides a level support for the computer in a field installation. This computer can operate normally within an ambient temperature range of -40° to 120° F and within a voltage range of 16 percent above or below the rated voltage (100 volts to 140 volts) with no loss of accuracy in the problem solution. In a fire control application, the computer facilitates ballistic trajectory computation by simulation of the flight of a projectile from the tube (or launcher) through a known nonstandard atmosphere to impact.

226. Gun Direction Computer M18 Capabilities

The M18 computer can solve the fire control problem for five batteries. Since the size of the computer memory permits one tube artillery program to contain the solution to the fire control problem for two calibers of weapons, the five batteries may be set up in any combination of the two weapon types for which a particular FADAC is programmed. Such combinations may be the 105mm and the 155mm howitzers, 105mm and 8-inch howitzers, 155mm howitzer and 175mm gun, etc. Part of each tube artillery program gives the computer the ability to perform traverse, intersection, and observer orientation computations, thus providing the computer a limited survey capability. In addition to the tube artillery programs, there are programs for the Little John and Honest John rockets, a program for meteorological data reduction, and a program for survey operations.

227. Operating Power

The gun direction computer M18 operates on 120/208-volt, 3-phase, 4-wire, 400-hertz power supplied by a standard 3-kilowatt (kw) Corps of Engineers generator. Since the rated power consumption of the FADAC is 700 watts (0.7 kw) adequate reserve power is available from the field generator to operate auxiliary devices and other items of equipment which may be used with the computer. The computer may fail to operate properly when the reserve power available is used to operate coffee pots, lights or other noncomputer associated equipment simultaneously with the computer. Insure that only computer items are using the power before higher echelon maintenance is called to repair a computer that fails to operate properly and the fault cannot be determined. Operating the M18 computer (FADAC) with outside items using the power source is not recommended. The computer table, used as a field mounting for the FADAC, also serves as a central power distribution point. Power is delivered from the generator to the table through a cable and reel assembly to jack J5 (fig. 90). Power is subsequently routed from the computer table through a pigtail cable to jack J11 on the computer. The same generator power delivered to J5 is also available through a multiple-outlet junction with four convenience jacks so that maintenance equipment or other auxiliary devices can be powered directly from the computer table.

228. Computer Components

The M18 computer consists of two major assemblies—the control panel assembly and the chassis assembly.

a. Control Panel Assembly. The control panel assembly incorporates those devices (manual keyboard, input matrix, Nixie tube readout, etc.) and functions (power and operating controls, etc.) which permit the operator to initiate, monitor, and control computer operation.

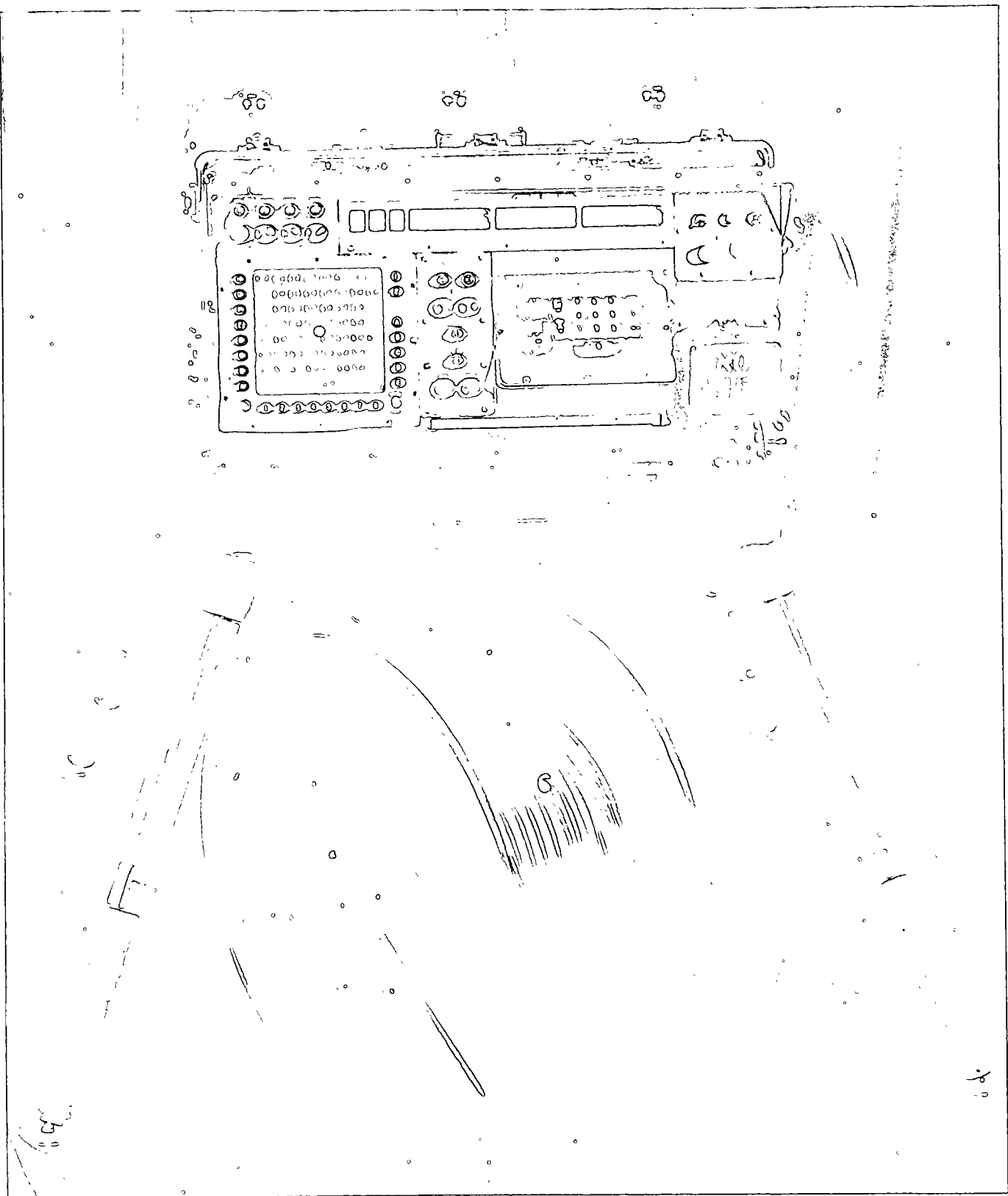


Figure 89. Gun direction computer M18 (FADAC).

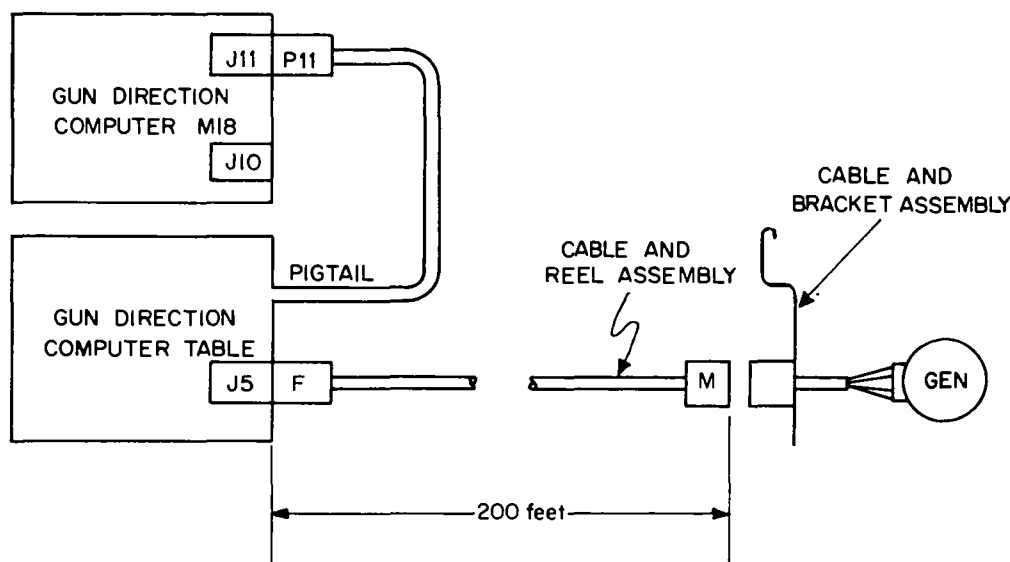


Figure 90. Connection diagram, generator to M18 (FADAC).

b. *Chassis Assembly.* The chassis assembly is comparable to the central processing unit of the commercial computer. It contains the computer memory (rotating magnetic disc), the 106 modular (plug-in) etched circuit boards of 20 different types, the power supply, and 2 air blowers for internal temperature control.

229. Control Panel Organization

a. *General.* As shown in figure 91, the M18 computer control panel assembly is organized into seven functional areas. For reference purposes, these areas are numbered as follows: (1) Power panel, (2) trouble indicator panel, (3) operator panel, (4) input display matrix, (5) manual keyboard, (6) indicator display panel, and (7) mechanical tape reader. They are labeled A, B, C, D, E, F, and G respectively in figure 91.

b. Panel Functions.

(1) *Power panel.* The power panel permits the operator to apply power to the computer and determine its readiness for operation.

(2) *Trouble indicator panel.* The trouble indicator panel gives the operator visual warning of internal temperature and three-phase input voltage conditions that are approaching operational limits. Other indicators show the operator when a parity error or a computational error has occurred.

(3) *Operator panel.* The operator panel consists of the controls that are used by the operator to initiate problem-solving computations and indicators that show the operator when the FADAC is

in a computing mode or in a keyboard entry (input-output) mode.

(4) *Input display matrix.* The input display matrix is a selection device which allows the operator to select and identify to the computer, the particular element of information that is to be entered in the computer through the keyboard.

(5) *Manual keyboard.* The keyboard is the device through which information may be manually entered into the portion of the memory reserved for that purpose. Prior to actual storage of keyboard entered data in the computer memory, such data are displayed for verification purposes on the keyboard for recalling and displaying previously entered data and clearing erroneously keyed information.

(6) *Indicator display panel.* The indicator display panel consists of a series of Nixie tube indicators which provide a display of information into the computer, memory, a display of recalled data, or display of a problem solution.

(7) *Mechanical tape reader.* The mechanical tape reader is capable of receiving meteorological data from five-channel teletype tape. After these data have been read by the tape reader, they are used by the computer to modify the solution to the fire control problem.

230. Computer Checkout Procedures

a. *Power Application.* A standardized computer checkout procedure is used to determine whether the computer is functioning properly and whether it is ready for problem solving. The initial step in checkout is the application of power to the com-

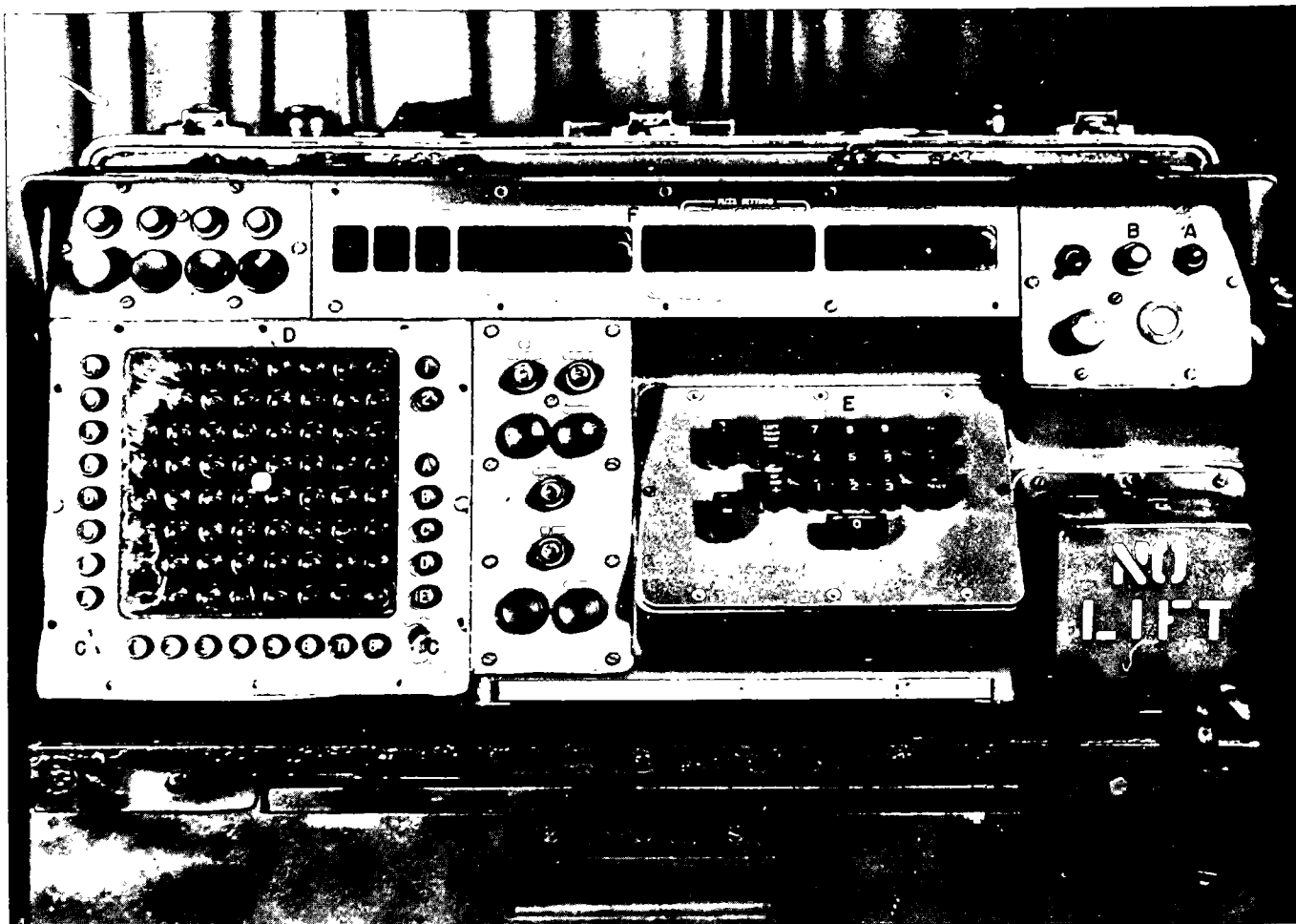


Figure 91. M18 control panel organization.

puter by operation of the POWER ON-OFF switch (A, fig. 91). After a delay of approximately 20 seconds (to permit the rotating memory disc to attain its full operational speed of 6,000 rpm), the POWER READY indicator (B, fig. 91) lights. When this indicator lights, the computer is ready to be checked for proper functioning.

b. Program Tests. After the application of power, the FADAC checkout is continued by conducting the built-in program tests. There are two tests—the permanent storage program test and the temporary storage program test. The perma-

nent storage program test, or program test 1, is a check to determine whether the program is properly loaded in the permanent storage portion of the memory. The temporary storage program test, or program test 2, is a parity check of the information in the temporary storage portion of the memory. The correct indication for this test is a display, on the indicator display panel, of the address of the highest numbered channel in the memory that is being used for temporary storage.

Note. For both program tests, the correct initiating procedure and display is indicated in the operation manual of the FM 6-3-() series.

Section II. MAINTENANCE CONCEPTS

231. Gun Direction Computer M18 Maintenance Philosophy

The trend in equipment today is toward greater simplicity of maintenance. The simplicity of M18 maintenance, based on isolation and replacement of modular circuit boards, permits organic artil-

lery personnel to perform the maintenance, representing a practical way of achieving maximum operating time from the M18 and an impressive saving of training time and economy of personnel. The M18 maintenance technician is a radio mechanic who also received a moderate amount of training as a computer mechanic, (MOS 31B30).

232. Malfunction Recognition

Since M18 computer corrective maintenance procedures are based on the performance of a series of fixed-sequence diagnostic routines, pointed toward the identification and isolation of a malfunction, one associated problem area assumes critical importance. This area is best identified by the question: How does the M18 user (operator, supervisor, commander, or technician) recognize a malfunction? Prompt and accurate recognition of a computer malfunction depends primarily on the thoroughness with which operator procedures are followed. Numerous minor problems can be analyzed and corrected by the operator, thereby removing a burden from the maintenance technician and eliminating needless calls for his services.

233. Maintenance Aids

In addition to the built-in protective devices which assist the operator in checking out the computer and recognizing malfunctions, there are maintenance aids, both built-in and M18 associated, which are used by the operator to detect actual or suspected malfunctions and by the maintenance technician to perform corrective maintenance. The discussion of available maintenance aids is restricted in this section to a general description and the purpose of the aids.

a. Diagnostic and Program Tapes. Two types of prepunched paper tapes, diagnostic and programs, are issued with the M18 and its associated maintenance equipment for two purposes—to load a program into the computer memory and/or to troubleshoot a malfunction in the computer. Both types of tapes are issued in kit form as follows:

(1) *Prepunched program tape kit.* The program tape kit is issued with the signal data reproducer AN/GSQ-64 and consists of two tape cartridge assemblies, two flag cards, an overlay for the input display matrix, a clear memory tape (for use with program test 2), two copies of FM 6-3-1, and a night filter. The kit components are stored in a plastic container. Each of the two tape cartridge assemblies contains a program tape appropriate to the caliber of the weapon used by the

unit to which the M18 is issued. The issue of two identical program tapes with each kit insures that loss of, or damage to, one tape will not cause the using unit to be without a program tape should programming become necessary. Programming the M18 computer requires the use of the signal data reproducer, which is normally available only to maintenance personnel.

(2) *Prepunched test tape kit.* The test tape kit contains a series of five prepunched fan-folded paper tapes, lettered A through E, each of which is used in a malfunction troubleshooting role. Tapes B, C, D, and E, when run in association with the signal data reproducer and the computer logic unit test set, provide a test of circuits within the M18 computer. Tape A is used to provide circuit tests of the computer logic unit test set and the signal data reproducer. Organizational maintenance personnel use the test tapes to perform corrective maintenance at the using unit on an on-call basis.

(3) *Clear memory tape.* The clear memory tape is specially designed to be used in clearing those memory channels, checked in program test 2, which contain incorrect data. The tape is employed by user personnel and is entered into the M18 through the mechanical tape reader.

b. Signal Data Reproducer AN/GSQ-64. The signal data reproducer (SDR) (fig. 92), is an aid used in performing corrective maintenance. Test data, read from a test tape by the SDR, is sent to the computer logic unit test set. When used in a maintenance role, the SDR is used in conjunction with the computer logic unit test set and the M18 computer.

c. Computer Logic Unit Test Set AN/GSM-70. The computer logic unit test set formerly called FADAC Automatic Logic Test Set, or FALT is an aid used only in M18 corrective maintenance. Used in conjunction with the SDR and the M18, the FALT accepts test data from the SDR and uses this data in making tests of the M18 (FADAC) logic circuits. If a malfunction is detected by the FALT, the test tape automatically halts and the FALT indicates the probable location of the malfunction. If no malfunction is detected, the SDR continues to read from the test tape.

Section III. SIGNAL DATA REPRODUCER AN/GSQ-64

234. Description and Capabilities

a. Description. The signal data reproducer AN/GSQ-64 (fig. 92) is a portable, photoelectric, punched-tape reader which translates input information from the punched holes in a moving tape

into electrical pulse outputs at a speed of approximately 700 characters per second. The tape used with the reproducer is an opaque, fan-folded paper tape. It contains five channels of punched information and one channel of sprocket holes.

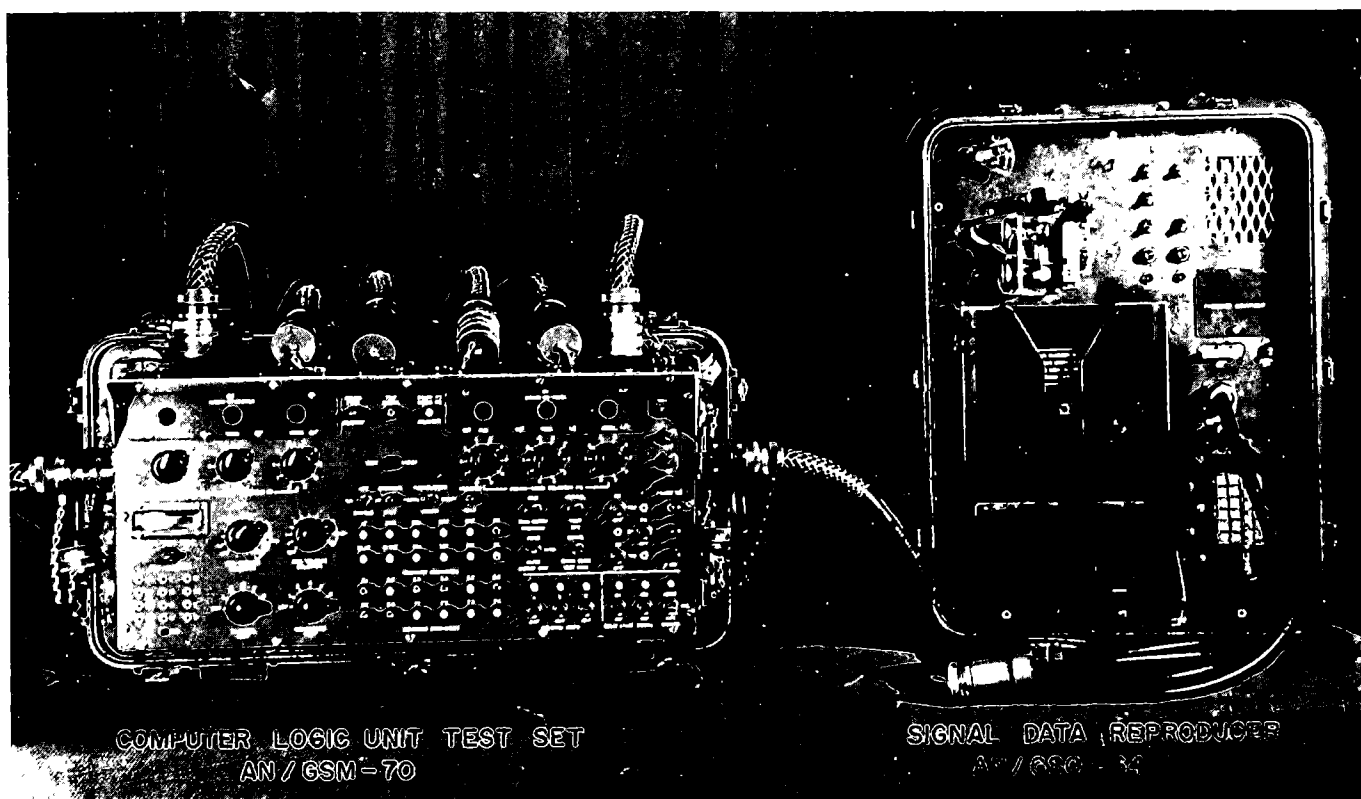


Figure 92. M18 computer peripheral equipment items.

The tape is furnished in a cartridge assembly (fig. 92), which is loaded at the front of the SDR. When the SDR is running, the punched tape feeds between a light source and a bank of light-sensitive photodiodes. Light passing through the punched holes causes the photodiodes to conduct so that current pulses are formed. These pulses are then amplified in the reproducer and sent to the unit to which the SDR is connected.

b. Capabilities. The signal data reproducer has two uses—to load prepunched programs into the M18 computer memory and, in conjunction with the FALT, to effect corrective maintenance tests of the M18 computer.

235. SDR Operation

When used in computer programing, the SDR is powered through one of the convenience outlets at the side of the computer table. Thus, the field generator which furnishes operating power to the FADAC serves also as a power source for the SDR. The power requirements for the SDR are the same as those for the M18 computer. Program information is transmitted by the SDR over a

signal cable that is connected to the M18 computer.

236. SDR Maintenance

a. Operator Maintenance. Preventive maintenance of the SDR is performed by the SDR operator. It is restricted to such services as inspection and cleaning of exterior surfaces, external visual examination for mechanical damage, tightening of loose hardware, operational checks of controls, inspection and cleaning of air filters, and inspection of cables for wear, breaks, cuts, and damage to connectors. For servicing intervals and authorized cleaning materials, see TM 9-1290-326-12.

b. Organizational Maintenance. Organizational maintenance services for the SDR are also primarily preventive in nature, although replacement of some parts is authorized. Parts replacement is restricted to replacement of the drive belt which connects the motor pulley to the capstan pulley, the air filter at the front of the SDR, the exciter lamps, and the indicator lamp assemblies. For instructions relative to the location and replacement of these parts, refer to TM 9-1290-326-12.

237. Description and Capabilities

The computer logic unit test set AN/GSM-70 (FALT) (fig. 92) is a transportable, semiautomatic, field test set used as a maintenance aid in locating malfunctions in the gun direction computer M18. The primary use of the FALT is to perform corrective organizational maintenance (in conjunction with the SDR) on the M18 computer. When used in a maintenance role, the FALT receives instructions from the SDR that cause certain conditions to be established at the inputs of the logic circuits in the FADAC. The FALT then checks the output of the FADAC logic circuit under test for proper state. If an improper state is detected, the test tape automatically halts and the FALT informs the operator that an error has occurred by displaying a test tape listing. For a detailed discussion of FADAC troubleshooting, see TM 9-1220-221-20/2 and TM 9-4931-204-12/2.

238. FALT Operation

Cabling Data and Power. Power requirements for the FALT are the same as those for the FADAC. In a maintenance situation, the FALT usually is powered through one of the convenience outlets on the computer table.

239. FALT Maintenance

a. Operator Maintenance. Preventive maintenance of the FALT is performed by the FALT

operator. It involves services such as inspection and cleaning of exterior surfaces, external visual examinations for mechanical damage, tightening of loose hardware; operational checks of controls, inspection and cleaning of air filters; and inspection of cables for wear, breaks, cuts, and damage to connectors. For servicing intervals and authorized cleaning materials, see TM 9-4931-204-12.

b. Organizational Maintenance. Organizational maintenance services for the FALT consist of replacement of selected parts, such as indicator lamp assemblies and air filters. Troubleshooting of the FALT at the organizational level is restricted to conducting the FALT self-test.

c. FALT Self-Test. Determining the operational status of the FALT is a function of the organizational maintenance personnel and is accomplished by running the FALT self-test (using the SDR and test tape A). The self-test provides a test of circuits within the FALT, as well as a check of the SDR and the connecting cable between the SDR and the FALT. The cabling of the SDR and the FALT for performance of the self-test is shown in figure 93. Step-by-step instructions for conducting this test are contained in TM 9-4931-204-12/2. If no test errors are detected during the semiautomatic execution of the test, the tape stops periodically in response to programmed halts and must be restarted as specified by instructions in the test tape printout. When an error is detected, the tape automatically stops, the TEST ERROR indicator lamp flashes, and a marker-index number is dis-

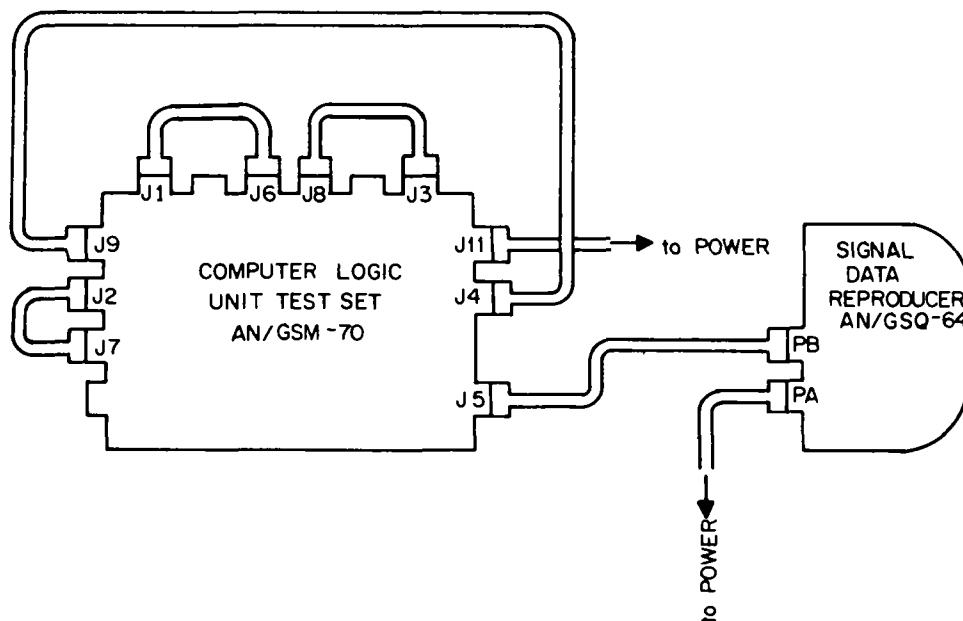


Figure 93. Cable connection diagram for FALT self-test.

played. The corresponding marker-index number is then located in the test tape printout, and the nature of the error is determined. Whenever the tape stops at an error, it cannot be started again until the error is cleared or until the "OPERATE"

control is momentarily held in the RESET position to permit bypassing the error. If the error cannot be cleared without replacing the board, the test set should be referred to a higher maintenance echelon for repair or replacement.

Section V. GUN DIRECTION COMPUTER M18 TROUBLESHOOTING

240. Organizational Maintenance Responsibilities

Organizational maintenance of the M18 computer is corrective in nature and includes removal and replacement of selected assemblies and parts and isolation of malfunctions by diagnostic troubleshooting. When a malfunction has been isolated to a component not authorized for replacement at the organizational level, field maintenance facilities must be contacted to effect repair (or replacement) of the M18. The assemblies and parts authorized to be removed and replaced at the organizational level are as follows:

- a. Input display matrix (D, fig. 91).
- b. Manual keyboard (E, fig. 91).
- c. Nixie indicator tubes (F, fig. 91).
- d. Mechanical tape reader (G, fig. 91).
- e. Circuit board assemblies.
- f. Power control relays.
- g. Matrix lamps and diodes.
- h. Power terminal strip on the field table.

241. Diagnostic Troubleshooting

The isolation of the majority of malfunctions in the FADAC at the organizational level has been made semiautomatic through the use of diagnostic tapes. The computer logic unit test set AN/GSM-70, driven by test tapes read by the signal data reproducer AN/GSQ-64, is used for isolation of malfunctions within the M18 computer. While isolation techniques will identify malfunctions occurring in both the plug-in type of etched circuit boards and the subassemblies of the control panel assembly, parts replacement to correct such malfunctions is limited to the replacement of those assemblies and parts listed in paragraph 248. The FALT is also used to monitor FADAC power supply output voltages. Elements of the M18 computer which are not checked by the diagnostic tapes are the power supplies and power control circuits, the air blowers, the field table, and the cable assemblies. With the exception of the power supplies and power control circuits, the operational status of these elements is determined by normal operator preventive maintenance services.

Section VI. GENERATOR SET

242. General Characteristics and Description

The FADAC operates on 120/208 volt, 3 phase, 4-wire, 400-hertz power supplied by a standard 3-kilowatt (kw) Corps of Engineers generator. The 3-kw generator is adequate to supply the FADAC, whose rated power consumption is 700 watts, and the other items of equipment (SDR and FALT) that are used with the computer. Since the FADAC is a primary fire control device, two generators are required to insure operational capability at all times, including periods of generator maintenance or breakdown. The military model HF 3.0 MD generator set, used with the FADAC, is a self-contained, frame-mounted, portable unit. It is powered by a four-cylinder military standard engine, which is directly coupled to the generator. The generator is a static-excited, 400 hertz alternating current generator with an output of 120/240 volts (single-phase) or 120/208 volts (three

phase). It is rated at 3 kilowatts at a 5,000-foot altitude. The set is complete with all controls and instruments necessary for normal operation.

243. Maintenance Services and Instructions

a. *General.* The generator set must be inspected systematically before operation, during operation, and after operation to insure that it is ready for operation at all times and that defects are discovered and corrected before they can result in serious damage or failure. The necessary preventive maintenance services must be performed before operation of the unit. Defects discovered during operation of the unit will be corrected as soon as operation has ceased. Operation must be stopped immediately if a deficiency is noticed which could damage the equipment if operation were to continue. "After-operation" services will be performed by the operator after every operating

period. After-operation services will be performed at intervals based on the normal operation of the equipment. The intervals between services should be reduced to compensate for abnormal conditions if they occur. Defects or unsatisfactory operating characteristics beyond the scope of the operator to correct must be reported at the earliest opportunity to organizational maintenance personnel. Responsibility for performance of preventive maintenance service rests not only with the operator but also with the entire chain of command from section chief to commanding officer (AR 750-5).

b. Daily Preventive Maintenance Services. Table A contains listing of preventive maintenance services which must be performed daily by the operator. The services listed in the table are the minimum services required and should be performed in the sequence in which they are listed.

c. Quarterly Preventive Maintenance Services. Table B contains a listing of preventive maintenance services which must be performed by the operator at quarterly intervals or after every 250 hours of operation, whichever occurs first. The services listed in the table are the minimum services required and should be performed in the sequence in which they are listed.

244. Table A. Preventive Maintenance Services—Daily

1. *Fuel strainer* — Ensure proper assembly and tighten the thumb nut if the gasket is leaking. (Clean strainer weekly.)
2. *Oil level gage.* Add oil as indicated by the gage level. Lubricate in accordance with the current lubrication order.
3. *Ground terminal.* Check for proper ground.
4. *Fuel tank* — Add fuel as required (with engine stopped).
5. *Controls and instruments.* Inspect for damage and loose mountings. With the unit running, check for proper operation. Normal op-

eration readings for instruments are as follows:

Voltage: 1-phase operation, 120 or 240.

Voltage: 3-phase operation, 120 or 208.

Load: 100 percent maximum in 3-phase operation.

Rpm: 3,600 maximum.

Frequency: 400 hertz.

6. *Operation* — During operation, observe for any unusual noise or vibration. Ensure that there are no noncomputer associated items on the power line.

245. Table B. Preventive Maintenance Services—Quarterly

1. *Fuel strainer* — Tighten the thumb nut if the gasket is leaking. Clean the strainer element.
2. *Spark plugs* — Replace spark plugs that have cracked insulators or burned electrodes. Clean and set spark plug gaps for 0.025 inch. Torque spark plugs to 25-27 foot-pounds. Replace leads which are frayed or broken. Clean and tighten lead connections.
3. *Oil level gage.* Add oil as indicated by the gage level. Lubricate in accordance with the current lubrication order.
4. *Magneto* — Replace pitted or burned magneto points. Adjust gaps to 0.018 inch; check adjustment every 500 hours.
5. *Ground terminal.* Check for proper ground.
6. *Fuel tank* — Add fuel as required. Tighten loose mounting. Replace leaking fuel tank. Replace defective cap gasket. Clean cap vent.
7. *Controls and instruments.* Replace damaged instruments. Tighten loose mountings. With the unit operating check for proper operation.
8. *Operational test.* During operation, observe for any unusual noise or vibration.
9. *Adjustments* — Make all necessary adjustments to correct for faults observed during operation.

Section VII. SUMMARY OF MAINTENANCE PUBLICATIONS

246. Operator Maintenance

The FADAC operator is responsible for operator maintenance on the FADAC and the two generators. His duties are clearly defined in the following publications:

TM 5-2805-203-14

TM 5-6115-271-15

TM 9-1220-221-10

247. Organizational Maintenance

The organizational Radio/FADAC repairman

(MOS 31B30) is responsible for organizational maintenance of the FADAC, and associated test equipment. His duties are clearly outlined in the following publications:

TM 9-1220-221-20/1

TM 9-1220-221-20P

TM 9-1220-221-20/2

TM 9-1290-326-12

TM 9-1290-326-20P

TM 9-4931-204-12/1

TM 9-4931-204-12/2

TM 9-4931-204-20P

CHAPTER 20

COMMUNICATION SYSTEMS

248. General

A communication system is the result of a communication plan designed to fulfill the requirements of a specific mission. It is based on the assigned mission of a unit, the table of organization and equipment (TOE) of a unit, the available communication means, and the principles of communication. A prearranged communication plan should be incorporated in the standing operating procedure (SOP) of all artillery units and must be kept current. A communication system must be carefully planned, must be simple, and must be used by a unit during its various training phases. When properly planned, a communication system will eliminate the publication of numerous and detailed signal orders and instructions, will increase the efficiency of the system, and reduce the reaction time of the unit. Such a system will include wire and radio facilities.

249. Wire System

The extent of a unit's wire system will depend on the length of time a unit remains in a position. Priority is always given to the installation of wire circuits necessary for the conduct of fire. A wire system is continually improved by installing duplicate lines over alternate routes, constructing overhead wire crossings, cabling multiple lines, and rerouting lines around exposed points in the system.

250. Radio Nets

Two or more radios (stations) operating together on a common frequency constitute a radio net. When several stations are operating in a net, the station representing the senior commander, or another designated station, is the net control station (NCS). According to their use, radio nets are divided into two types—internal nets and external nets.

a. Internal Nets. Internal radio nets are those nets required within a unit and through which a commander can control the elements of his immediate command.

b. External Nets. External radio nets are those nets through which a commander can communicate with elements outside his immediate command.

251. Communication Requirements

The communication requirements for field artillery units are based on the organization and the mission of each unit. The communication system of a unit is designed to meet the internal and external requirements of these units.

a. Internal Requirements. The internal communication requirements include facilities for—

- (1) Tactical and administrative control and supervision.
- (2) Fire control.
- (3) Fire direction.
- (4) Collection, exchange, and dissemination of information and intelligence.
- (5) Dissemination of warnings.
- (6) Dissemination of meteorological data.
- (7) Coordination of survey.

b. External Requirements. The external communication requirements include facilities for—

- (1) Tactical and administrative control and supervision.
- (2) Receipt of fire missions.
- (3) Requesting additional fire support.
- (4) Coordination of fire support.
- (5) Collection, exchange, and dissemination of information and intelligence.
- (6) Receipt of warnings.
- (7) Receipt of accurate time.
- (8) Receipt of meteorological data.
- (9) Coordination of survey.
- (10) Coordination of air traffic.
- (11) Communication with supported unit (when applicable).
- (12) Communication with reinforced unit (when applicable).

252. Functions of Radio Nets

Internal and external radio nets are also designated according to their specific functions. Since the internal and external requirements of the various field artillery units vary, not all field artillery units will require all the nets listed in *a* through *ab* below. The radio nets may be frequency modulated (FM) or amplitude modulated (AM) nets.

a. Air Defense Section Net, FM (AD). The air defense section net is an internal net operated at field artillery battalion level. Its purpose is to provide exclusive FM communication between the section leader of the Redeye section and the members of the Redeye teams.

b. Air Defense Intelligence Net, AM (AD Intel). The air defense intelligence net, AM, is operated by an Army air defense command post (AADCP) of the combat area. This net is used to disseminate intelligence pertaining to airstrikes and other information pertaining to enemy air activities within the area of responsibility. Division artilleries monitor this net.

c. Administrative/Logistics Net, AM, RATT (Admin/Log). The administrative/logistics net, AM is used by a major combat units, supporting elements and supply elements to transact administrative and logistical business.

d. Air Net, FM. The air net, FM, is an internal radio net. It provides FM communication between the organic helicopters of a battalion and its aviation section. (Pershing battalion.)

e. Air Request Net, AM (Air Req). The air request net, AM, is used by combat units to forward requests for tactical air support directly to a tactical operations center, and to disseminate information and instructions pertaining to airstrikes. The primary means of communication is provided by the tactical Air Force, which provides a direct channel from the forward air controller to the direct support center at corps.

f. Air Traffic Regulation Net, UHF (Air Traf Reg). The air traffic regulation net, UHF, is operated at corps and army flight operation center (FOC) to coordinate the operations of Army aircraft with the army air defense command post, which in turn coordinate with the Air Force. The primary means used by the flight operations center (FOC) to effect such coordination are teletypewriter facilities in sole-user circuits in the army area system, using teletype facilities. As an alternate means and also to provide UHF equipment to communicate with other army aircraft in the area, the aircraft and the aviation sections are

equipped with UHF radio sets, which operate in an air traffic regulation net.

g. CG/Command Net, FM (CG Comd). The CG/command net, FM, provides a direct channel of communication between a division commander and all commanders of major units operating directly under division control. Other uses of this net are governed by the desires of the respective division commanders. Subordinate commanders will not use this net for lateral communication unless specifically authorized to do so. An airborne relay station may be utilized in this net, if required.

h. Command Net, AM, RATT (Comd). The command net, AM, provides secure radio teletypewriter communications for transmission orders and for tactical control and administrative supervision. This net normally is used by army and corps to communicate with their organic artillery.

i. Command/Fire Direction Net, FM (CF). The command/fire direction net, FM, provides communication with elements of the staff, airborne aircraft, and subordinate units that are within range of FM equipment for tactical control, administrative supervision, and the exchange of information and intelligence. This net will also be used for fire missions when necessary.

j. Command/Fire Direction Net, AM, RATT (CF). The command/fire direction net, AM, provides secure radio teletypewriter communication for tactical control and administrative supervision of subordinate units, for dissemination of meteorological data, and for control of nuclear fire missions. It is also used to exchange information and intelligence.

k. Command/Intelligence Net, FM (CI). The command/intelligence net, FM is used by a commander for communication with his staff, in flight aircraft, and subordinate elements that are within the range capability of the equipment.

l. Command/Intelligence Net, AM, RATT (CI). The command/intelligence net, AM, provides a secure radioteletypewriter communication link between the units operating in this net. This net is used for tactical control, exchange of information and intelligence, and transmission of battlefield information.

m. Command/Light Direction Net, FM (CL). The command/light direction net, FM, is used for tactical and administrative control within a searchlight battery and its platoons to direct and process light direction missions. In normal situations, the battery commander may not be within

range of all elements of his battery; however, with proper siting of radios and use of proper antennas he should be able to communicate with the platoon commanders, who are able to communicate with their sections.

n. Command/Operation Net, FM (CO). The command/operation net, FM, provides a direct FM radio channel for control, command, and administration of a unit. It ties together the commander, the staff, and the various sections of the command that are within FM range.

o. Fire Direction Net, FM (F). The fire direction net, FM, is used to process fire missions and to exchange information and intelligence. Some field artillery units require more than one fire direction net, in which case the nets are numbered F1, F2, etc.

p. Fire Direction Net, AM, RATT (F). The fire direction net, AM, is used for coordination of artillery fire between major field artillery echelons and also for requesting additional fire support from a higher field artillery headquarters without having to go through regular command channels. It is a secure radio teletypewriter net.

q. Flash Ranging Net, FM (T). The flash ranging net, FM, is an internal radio net of a target acquisition battery. It is used by the flash ranging platoon to exercise control over subordinate elements and to obtain battlefield information and direction to hostile targets from the flash ranging observers.

r. Link-Up Net, AM RATT. The link-up net, AM, is a radio teletypewriter net in the airborne division which provides communication between division artillery in the objective area and friendly field artillery of the link-up force. This net is essential for field artillery fire coordination.

s. Liaison Net, AM, (LN). The liaison net, AM, provides communications between the headquarters of a command and its liaison officers. It is used for control of the liaison officers and for exchange of information and intelligence.

t. Meteorological Net, AM, (M). The meteorological net, AM, is used for broadcasting meteorological data on a prearranged time schedule. This net is also used for coordination of radiosonde frequencies and time schedules. Field Artillery units normally receive meteorological data from division artillery, corps artillery, or field artillery group by radio teletypewriter over a command/fire direction net, AM, but they may also obtain this data direct by monitoring this meteorological net. The net control station of this net belongs to

the target acquisition battalion of corps artillery. This voice net is used for backup of the RATT transmissions.

u. Operation/Intelligence Net, AM, RATT (Op/Intel). The operation/intelligence net, AM, is an internal net of a division. It is used by the division artillery to receive commands and operation orders from the division. In addition, this net provides a secure radio teletypewriter link between the division artillery and the major combat elements of the division. This net also is used for the exchange of information and intelligence between division artillery and the division.

v. Security Net, FM (Scty). The security net is an internal net used by some units with a nuclear capability. This net provides communications within an ammunition train en route and also provides a means to communicate with a check-in or relay point or the parent unit while engaged in transporting nuclear components. Also used for security of SASP, when applicable.

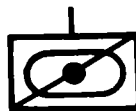
w. Sound Ranging Net, FM (R). The sound ranging net, FM, is an internal radio net of target acquisition battery. It is used by the sound ranging platoon to exercise control over subordinate elements and to obtain battlefield information from its sound ranging observers.

x. Spot Report Receiver System, UHF. The spot report receiver system, UHF, is an Air Force net, used to furnish instantaneous and fragmentary reports by airborne pilots on the results of air-strikes and observations. This net is used by fighter planes and reconnaissance planes. Interested army units and installations can monitor this net to receive such information directly and without delay.

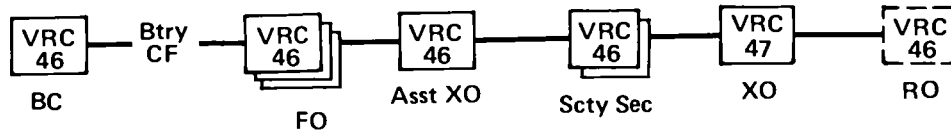
y. Survey Channel, FM (S). The survey channel, FM, may be allocated by corps artillery thereby reducing the number of frequencies required. This channel is common to all artillery survey sections within a corps artillery sector and provides local communication within or between these survey sections. Although this channel is commonly referred to as the corps artillery survey net, operation as a coordinated net is neither intended nor feasible. If interference exists between units, normal radio procedure will prevent confusion.

z. Tactical Air Observation Net, UHF, (TAO). The tactical air observation net, UHF, is an air force net. Tactical high performance aircraft and artillery units may communicate over this net for adjusting long-range artillery fire or for surveillance of the effects of nuclear fire.

1	GRR-5
3	GRC-125
2	PRC-6
11	VRC-46
1	VRC-47
1	GRC-106



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EXTERNAL NETS

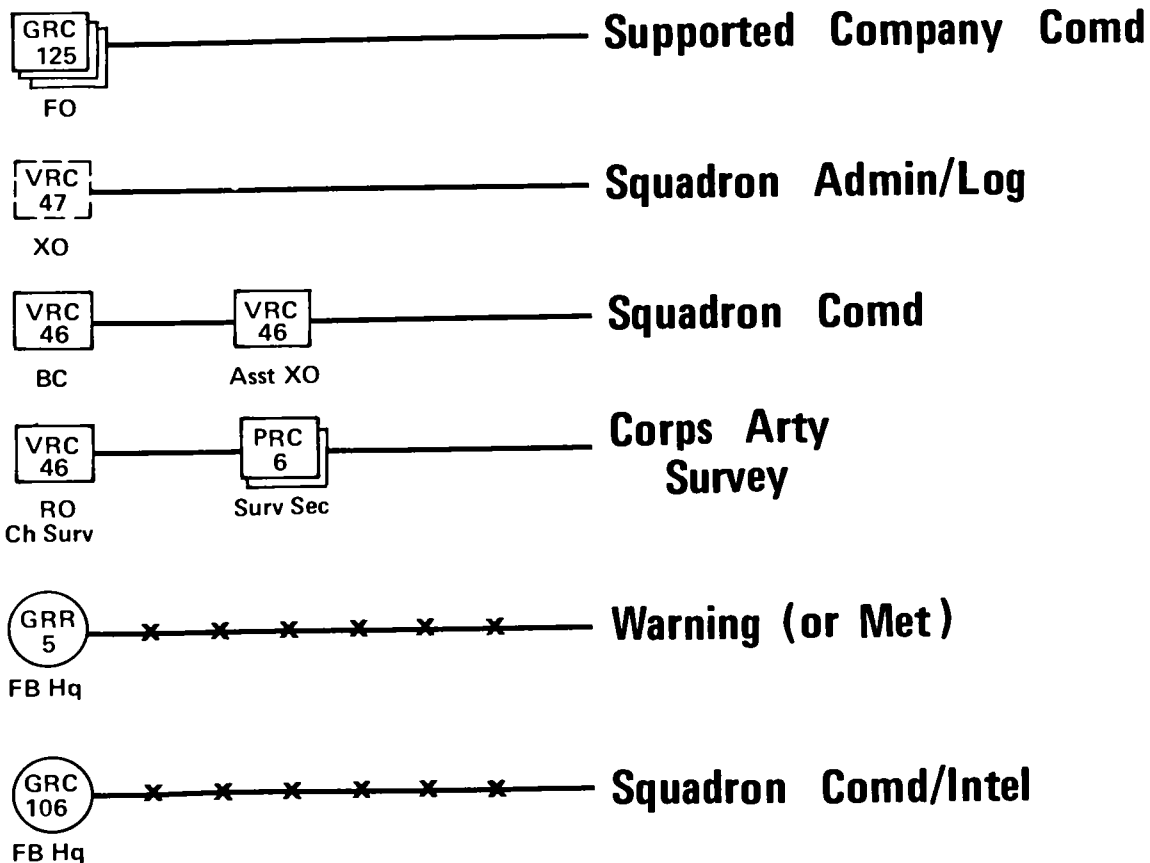


Figure 94. Radio net, 155-mm battery, armored cavalry squadron, TOE 6-37G.

aa. Time Signal Net, AM. The time signal net, AM, is used to broadcast the official time throughout an entire theater of operations. The theater commander usually designates one station to broadcast the accurate time in accordance with a planned and published schedule. In addition to being used for broadcasting the official time it can be monitored by artillery units that have the ca-

pability to conduct astronomical observations, and therefore require accurate time.

ab. Warning Net, AM (Wng). The warning net, AM, is operated by divisions and other higher echelons. A warning net is used to broadcast warnings of air alerts; chemical, biological, and radiological attacks; nuclear strikes; fallout patterns; and similar information of an urgent oper-

ational nature. Division Artillery operates a radio station in the division warning net as it must broadcast warnings pertaining to hostile aircraft receive over the air defense intelligence net (b above). All other field artillery units down to and including batteries monitor this net.

253. Type Wire Systems and Radio Nets

Type wire systems and radio nets are listed by table of organization and equipment (TOE) in

figures 94 through 153. All equipment shown on these diagrams is strictly according to the "G" series of TOE's. As radio equipment becomes obsolescent, other items of new equipment may be issued as they are phased into the Army inventory. As an example, the AN/GRC-46 radio teletype-writer set has been declared a standard "B" item and is being replaced by the new AN/GRC-142 single sideband equipment. Other changes of a similar nature can be expected.

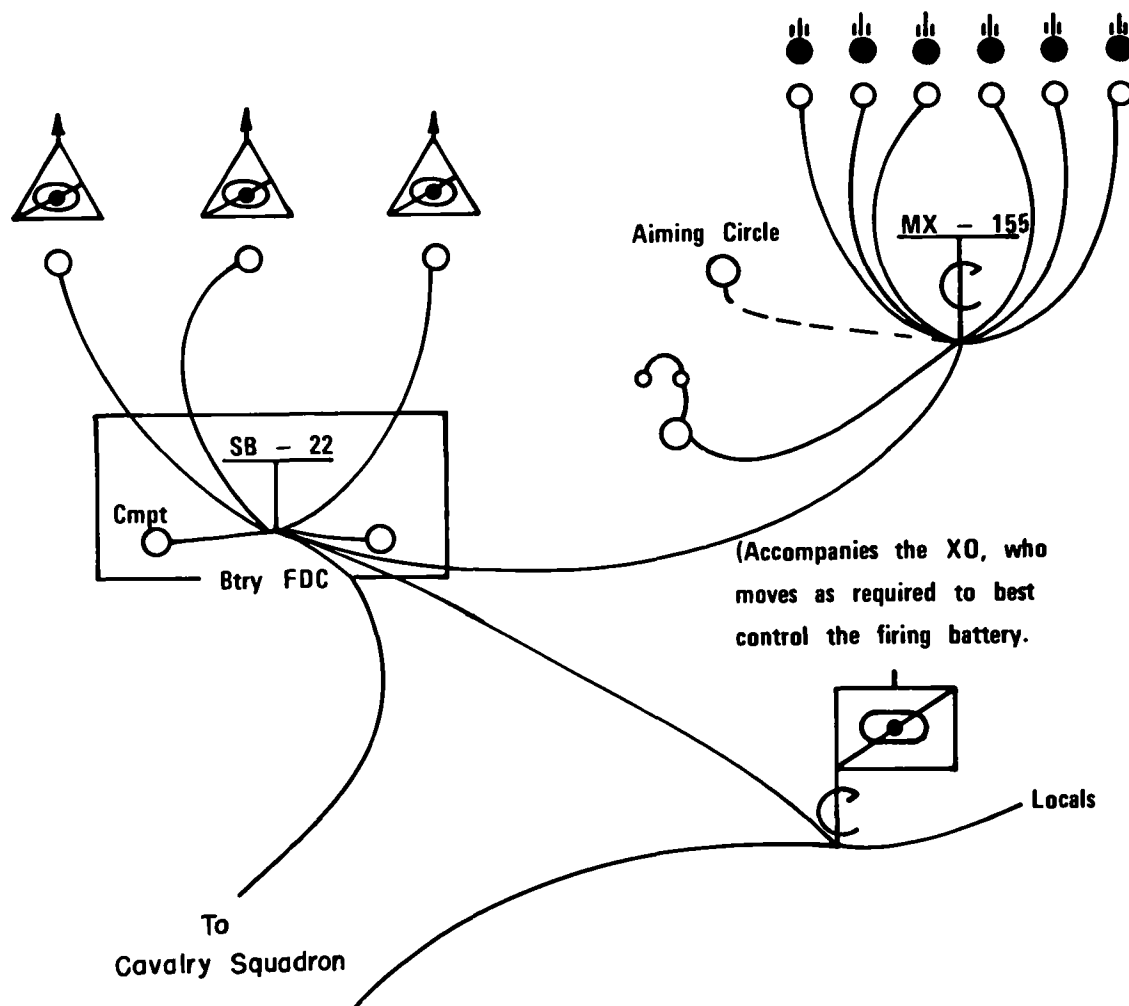
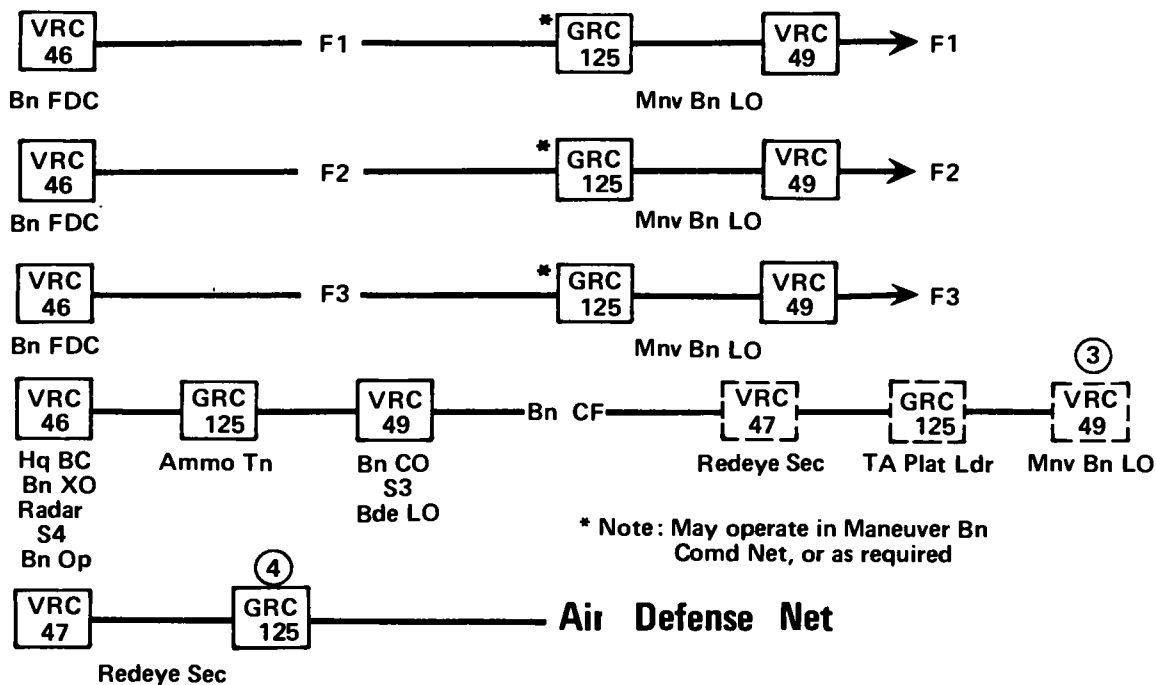
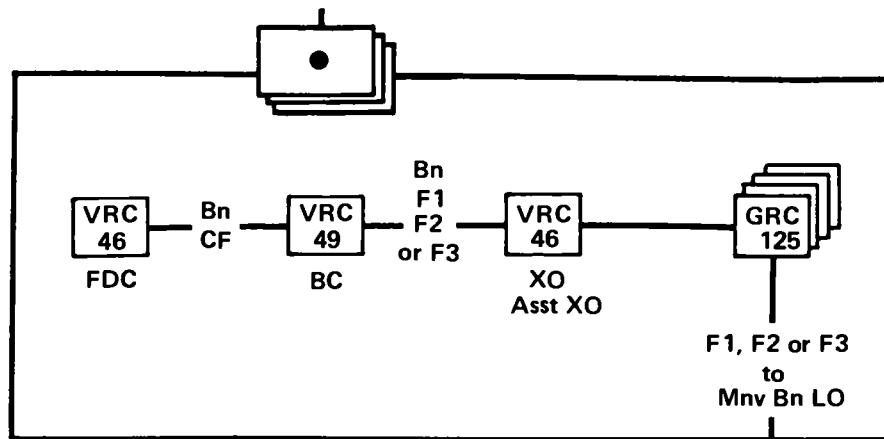


Figure 95. Wire system, 155-mm battery, armored cavalry squadron, TOE 6-37G.

5	GRR-5
21	GRC-125
4	PRC-25
18	VRC-46
1	VRC-47
10	VRC-49
1	VSC-2



EXTERNAL NETS

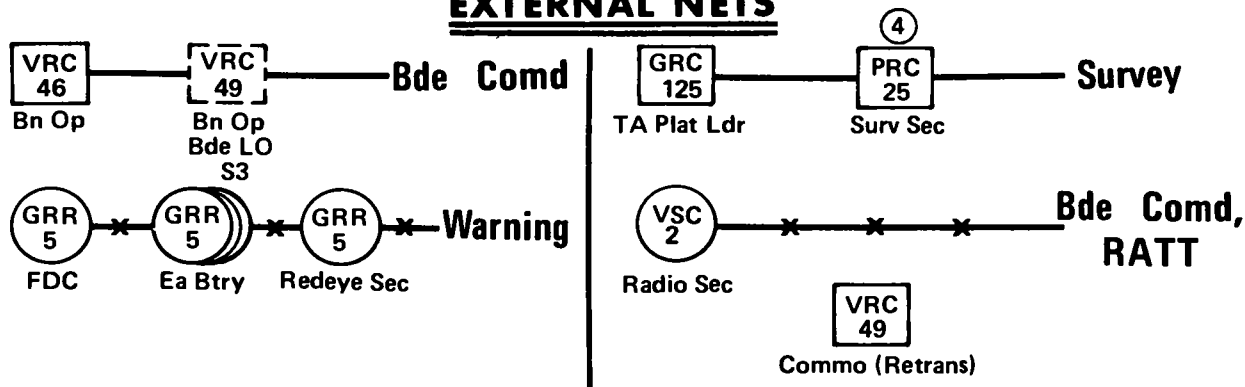
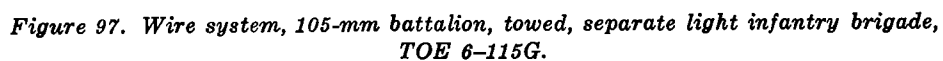
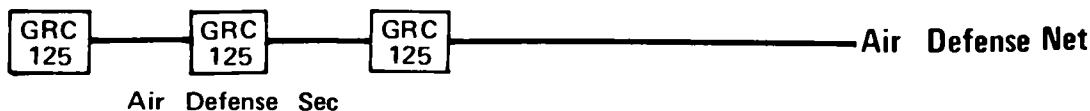
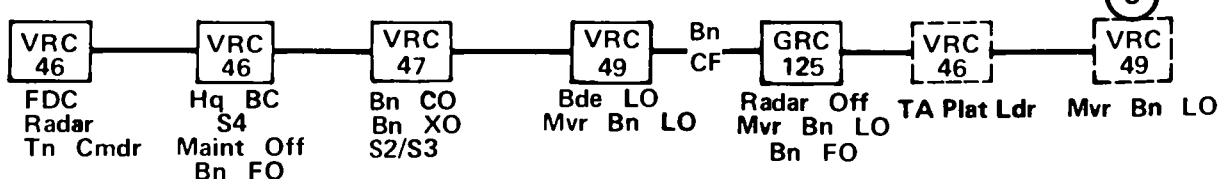
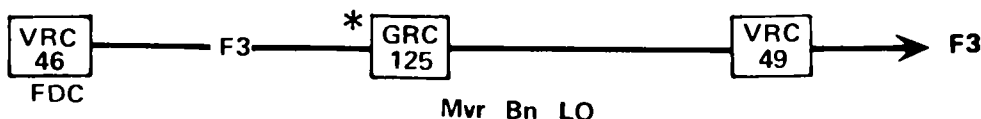
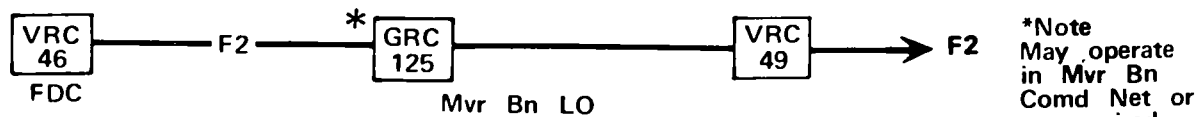
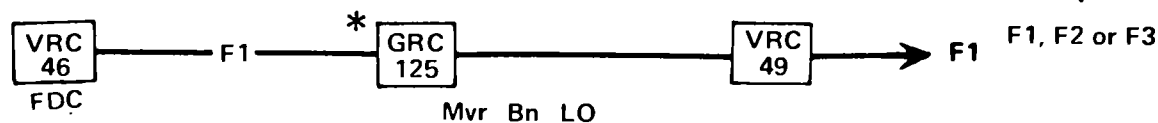
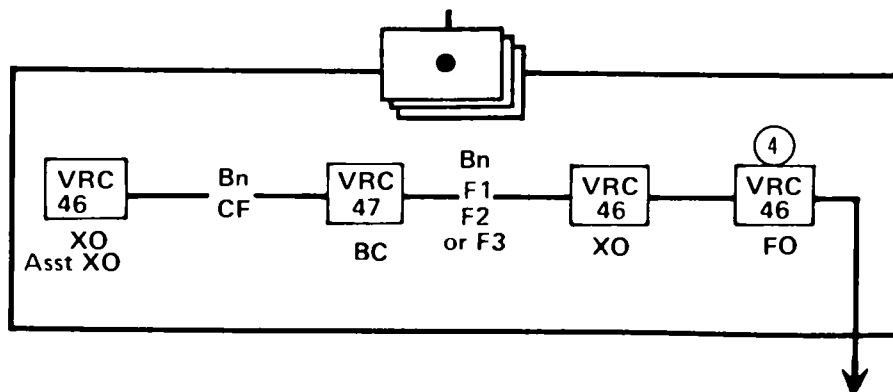


Figure 96. Radio nets, 105-mm battalion, towed, separate light infantry brigade, TOE 6-115G.



5	GRR	5
21	GRC	125
4	PRC	6
35	VRC	46
6	VRC	47
6	VRC	49
2	GRC	46



EXTERNAL NETS

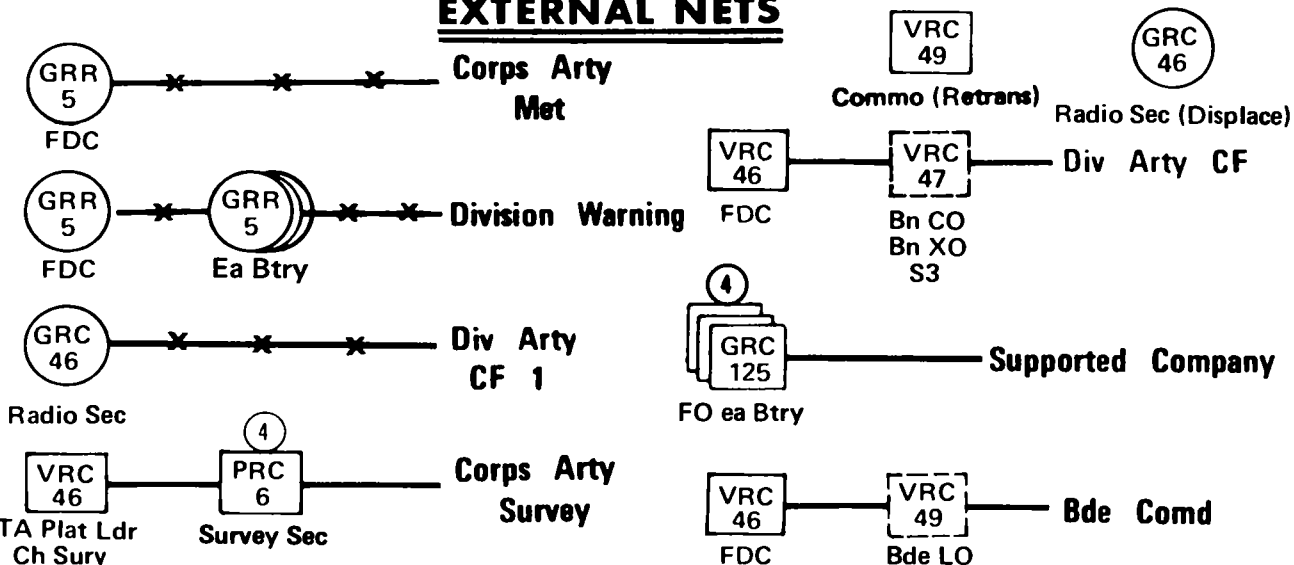


Figure 98. Radio nets, 105-mm towed DS battalion, infantry division, TOE 6-155G.

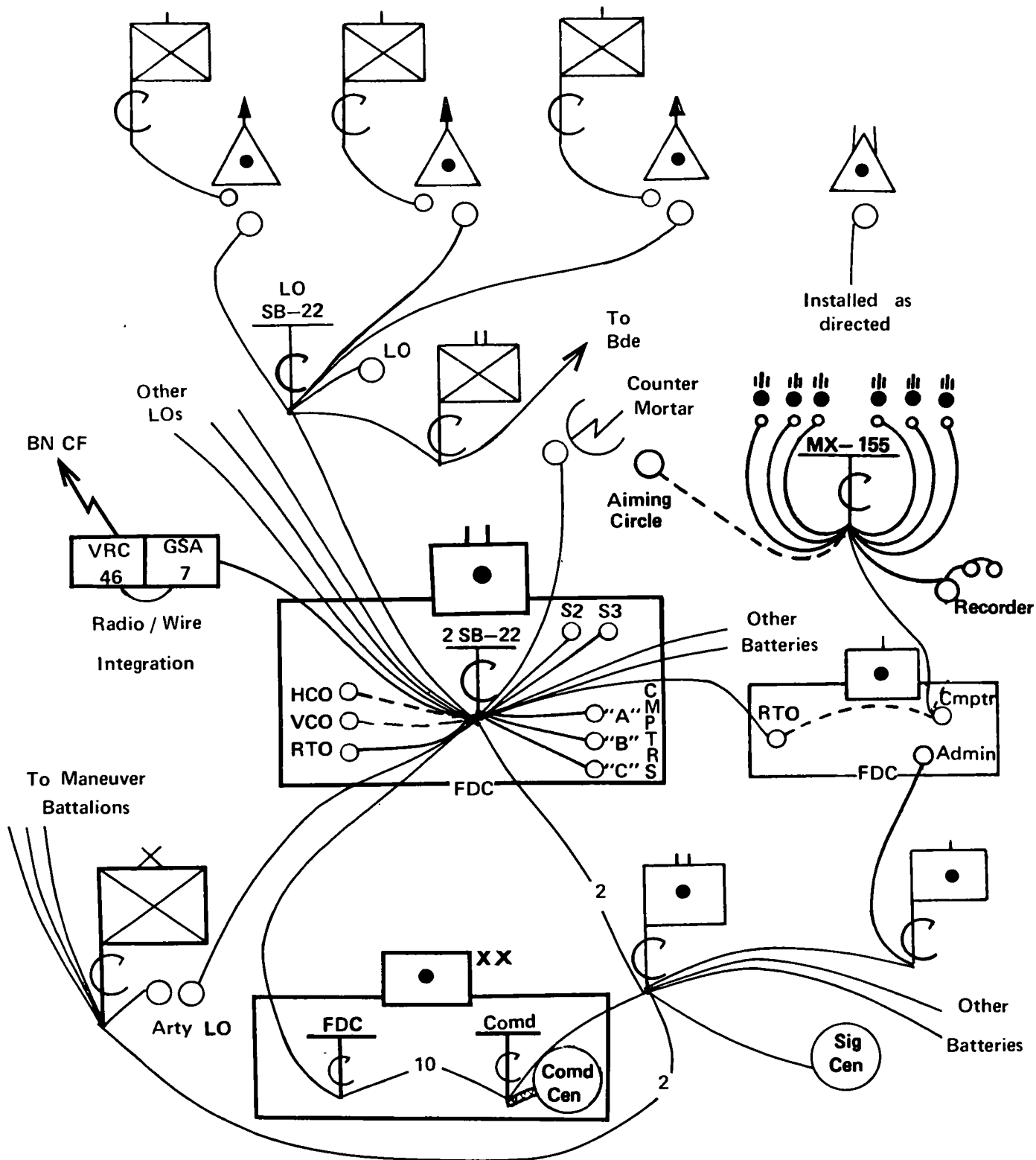
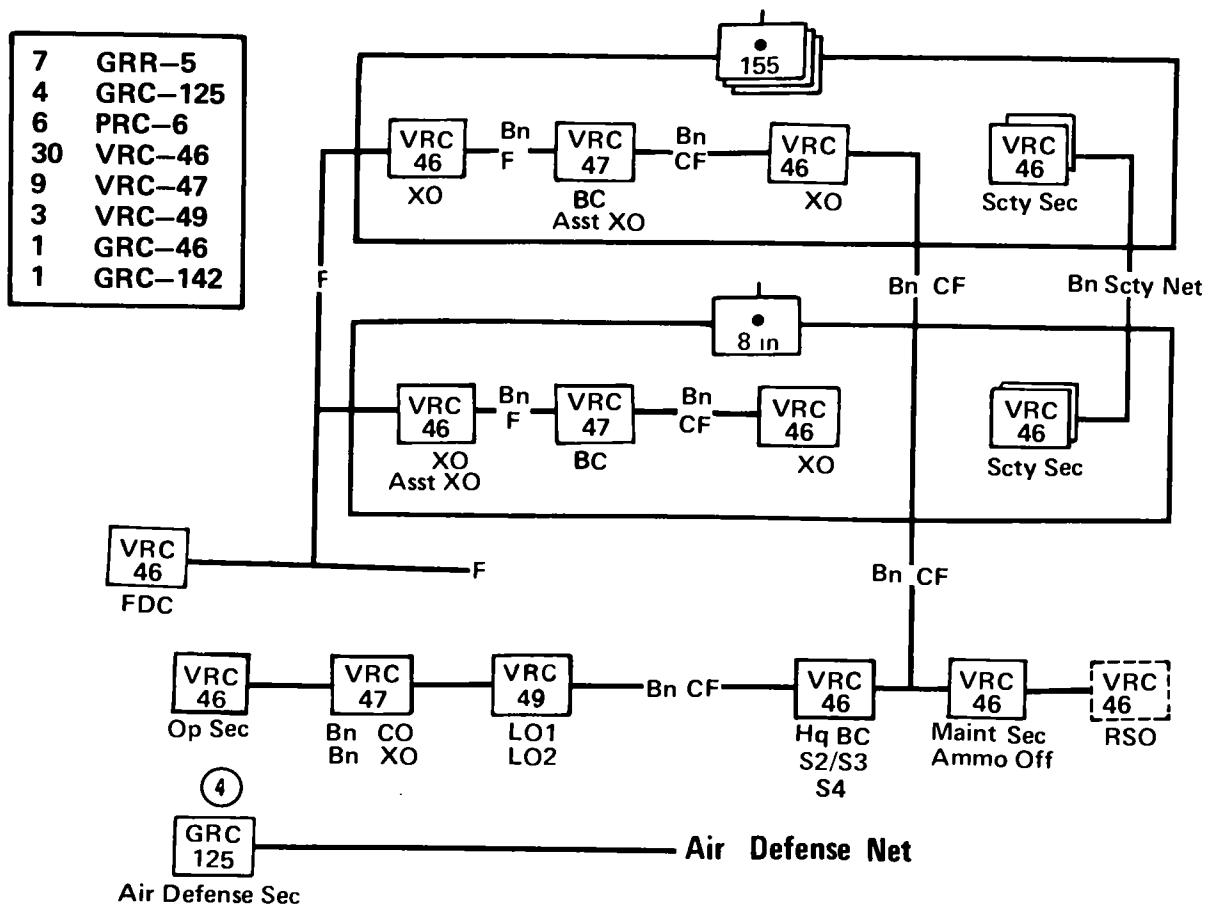


Figure 99. Wire system, 105-mm towed DS battalion, infantry division, TOE 6-155G.



EXTERNAL NETS

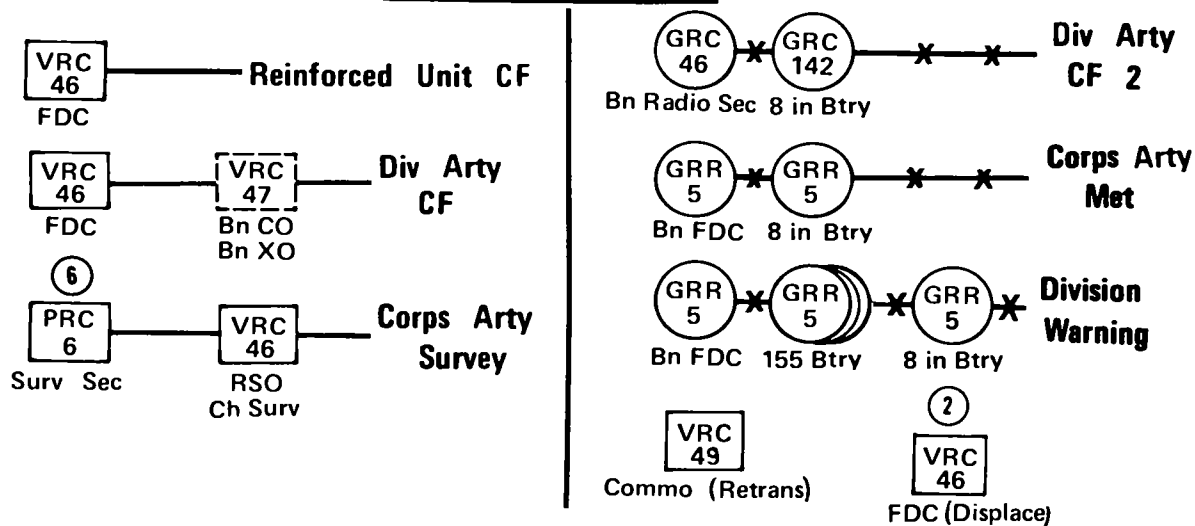


Figure 100. Radio nets, 155-mm towed, 8-inch SP battalion, infantry division, TOE 6-165G.

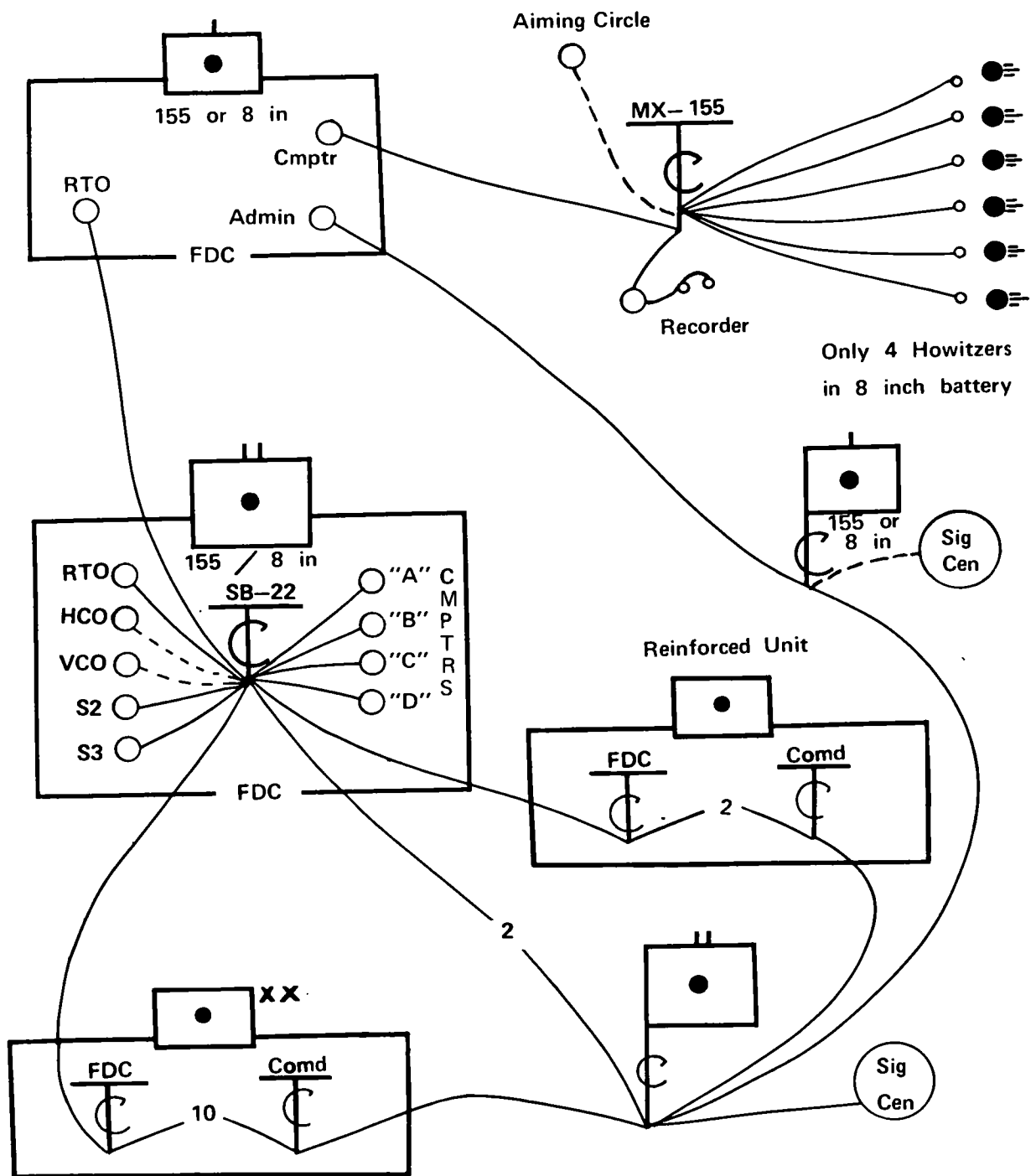
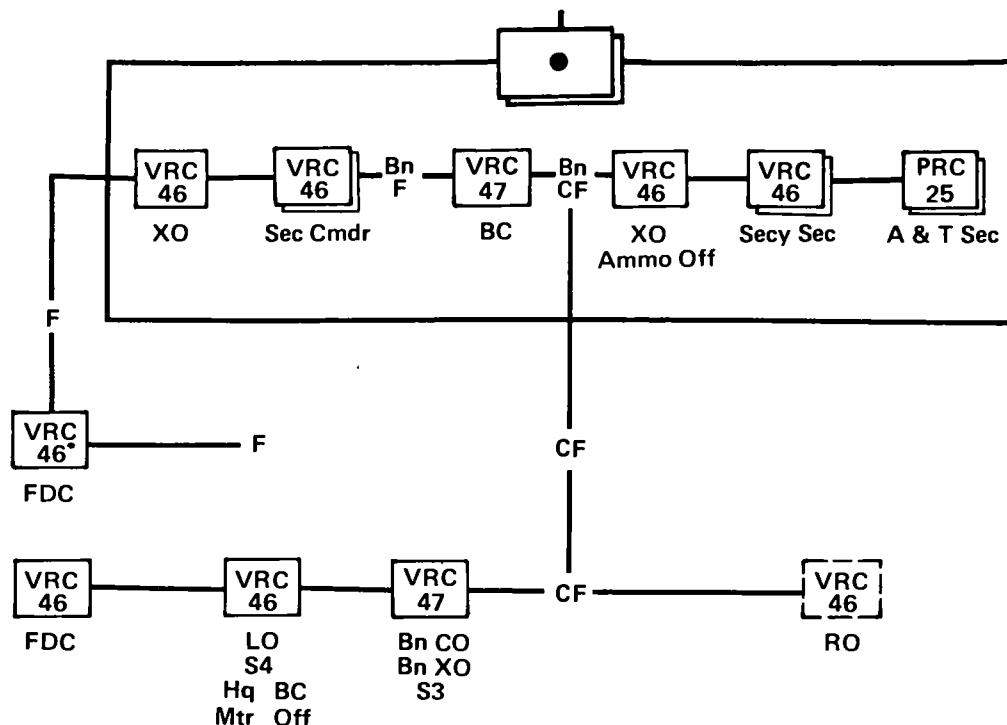


Figure 101. Wire system, 155-mm towed, 8-inch SP battalion, infantry division, TOE 6-165G.

6	GRR-5
4	GRC-125
4	PRC-25
23	VRC-46
5	VRC-47
1	VRC-49
3	GRC-46



EXTERNAL NETS

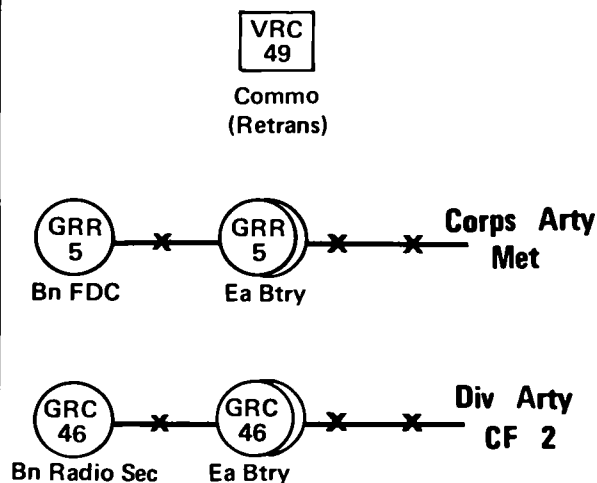
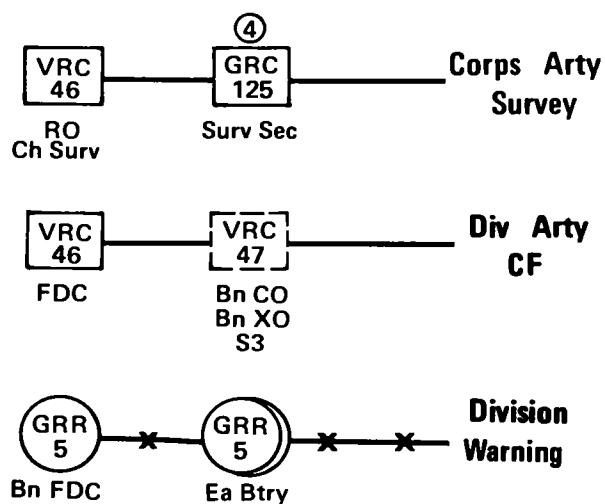


Figure 102. Radio nets, Honest John battalion, TOE 6-175G.

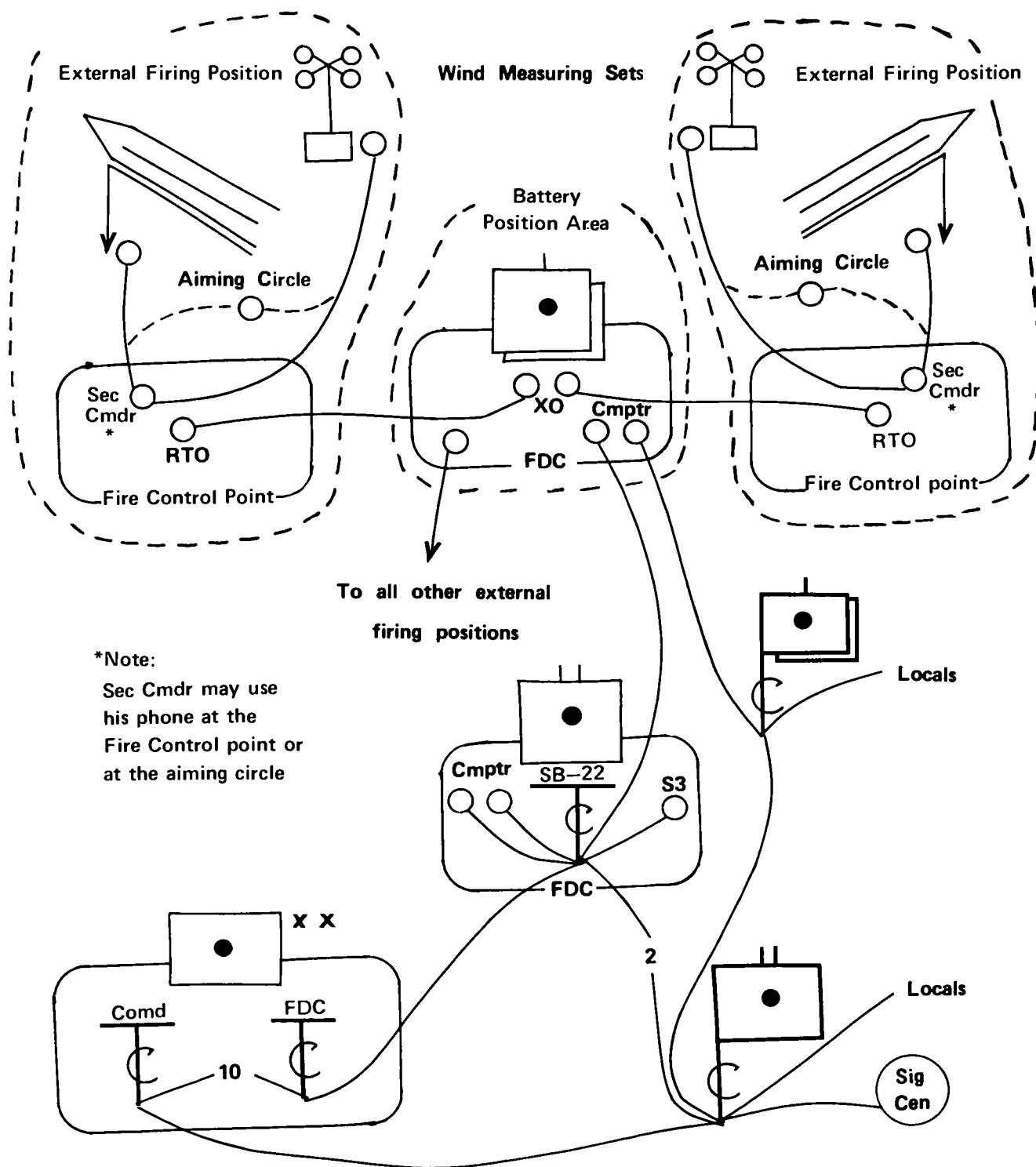
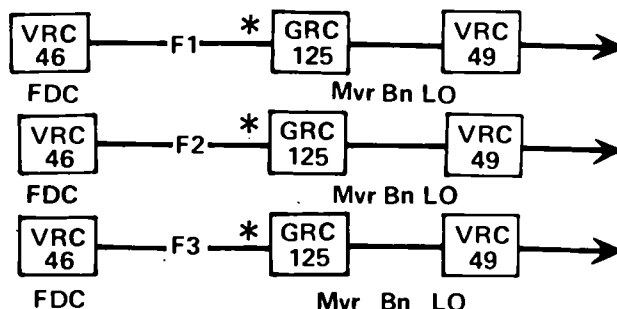
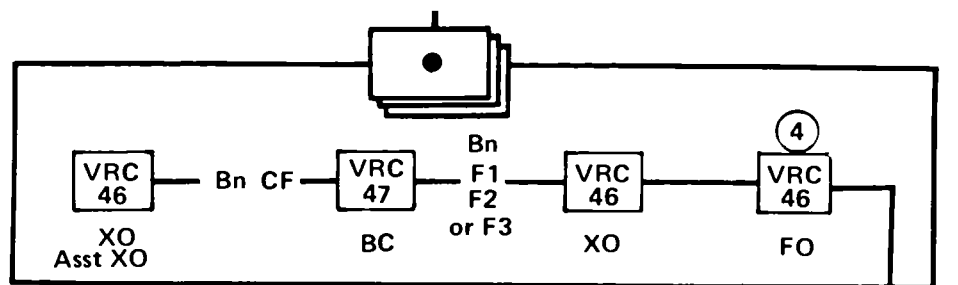
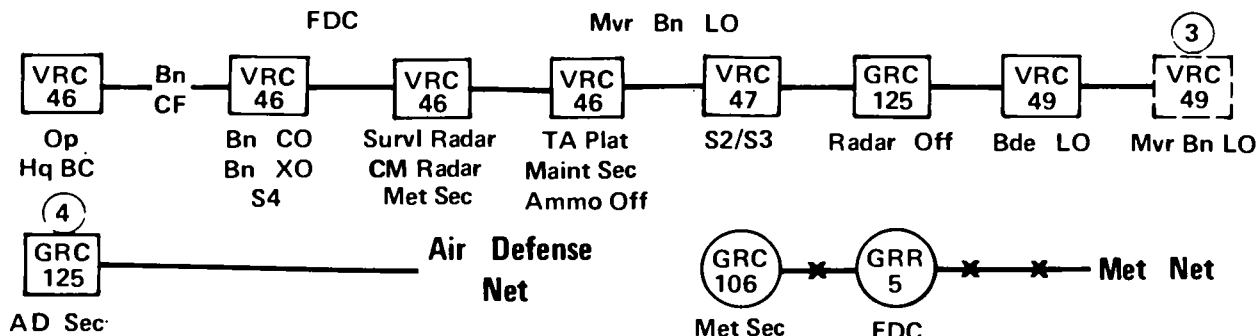


Figure 103. Wire system, Honest John battalion, TOE 6-175G.

- 5 GRR-5
- 20 GRC-125
- 1 GRC-106
- 4 PRC-6
- 40 VRC-46
- 4 VRC-47
- 5 VRC-49
- 2 GRC-46



*Note
May operate
in Mvr Bn
Comd Net or
as required



EXTERNAL NETS

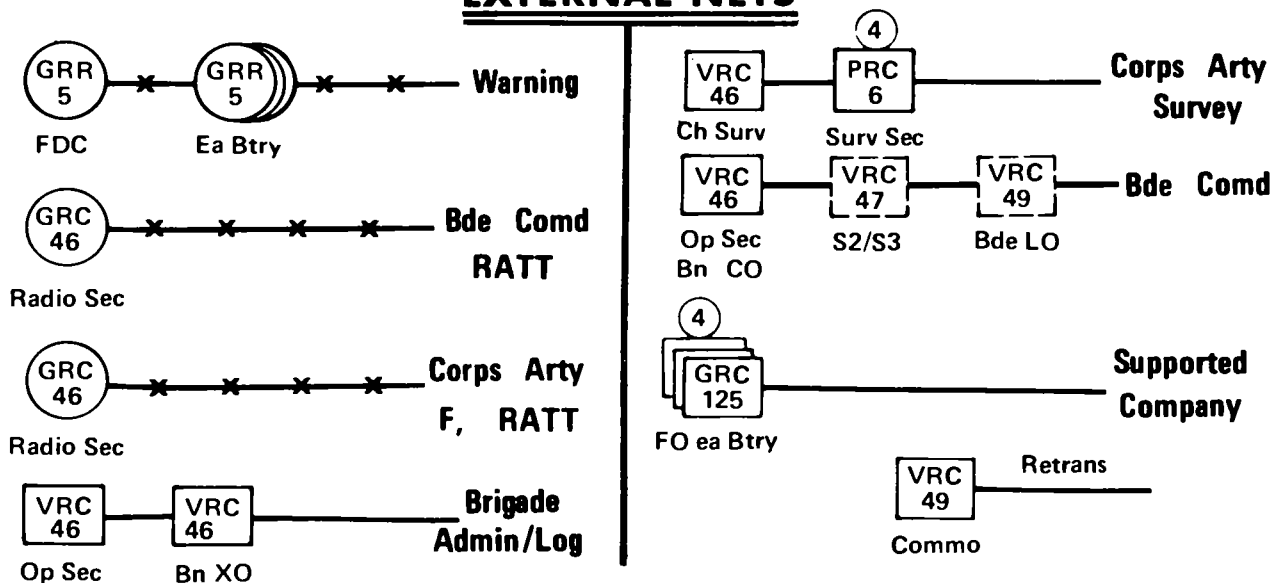


Figure 104. Radio nets, 105-mm battalion, towed, separate infantry brigade, TOE 6-185G.

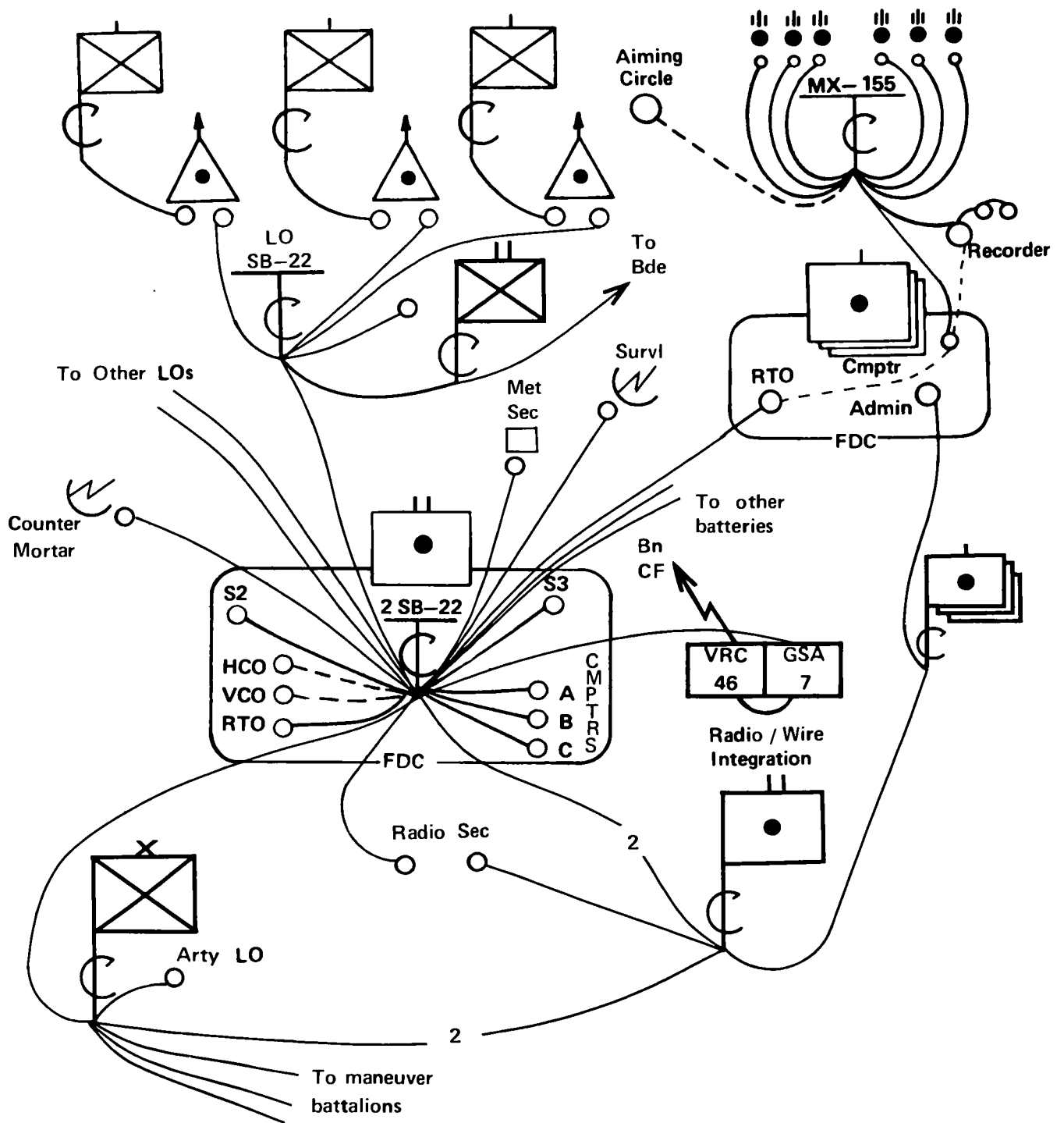
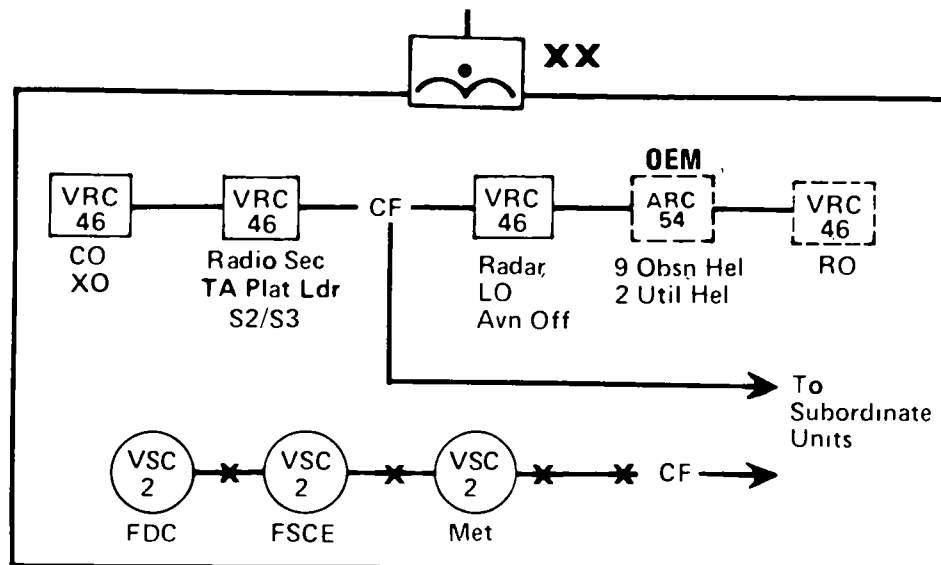


Figure 105. Wire system, 105-mm battalion, towed, separate infantry brigade, TOE 6-185G.

- 1 GRR-5
- 2 GRC-125
- 2 GRC-106
- 4 PRC-25
- 10 VRC-46
- 1 VRC-49
- 3 VSC-2



EXTERNAL NETS

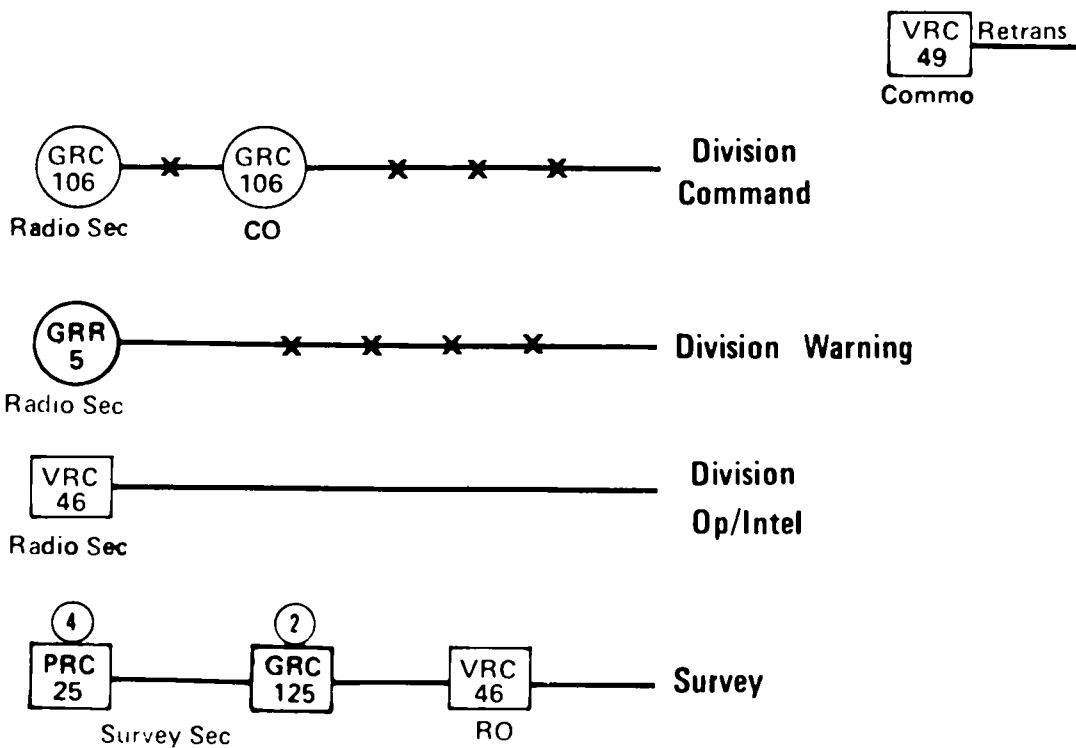


Figure 106. Radio nets, HHB, airborne division artillery, TOE 6-201G.

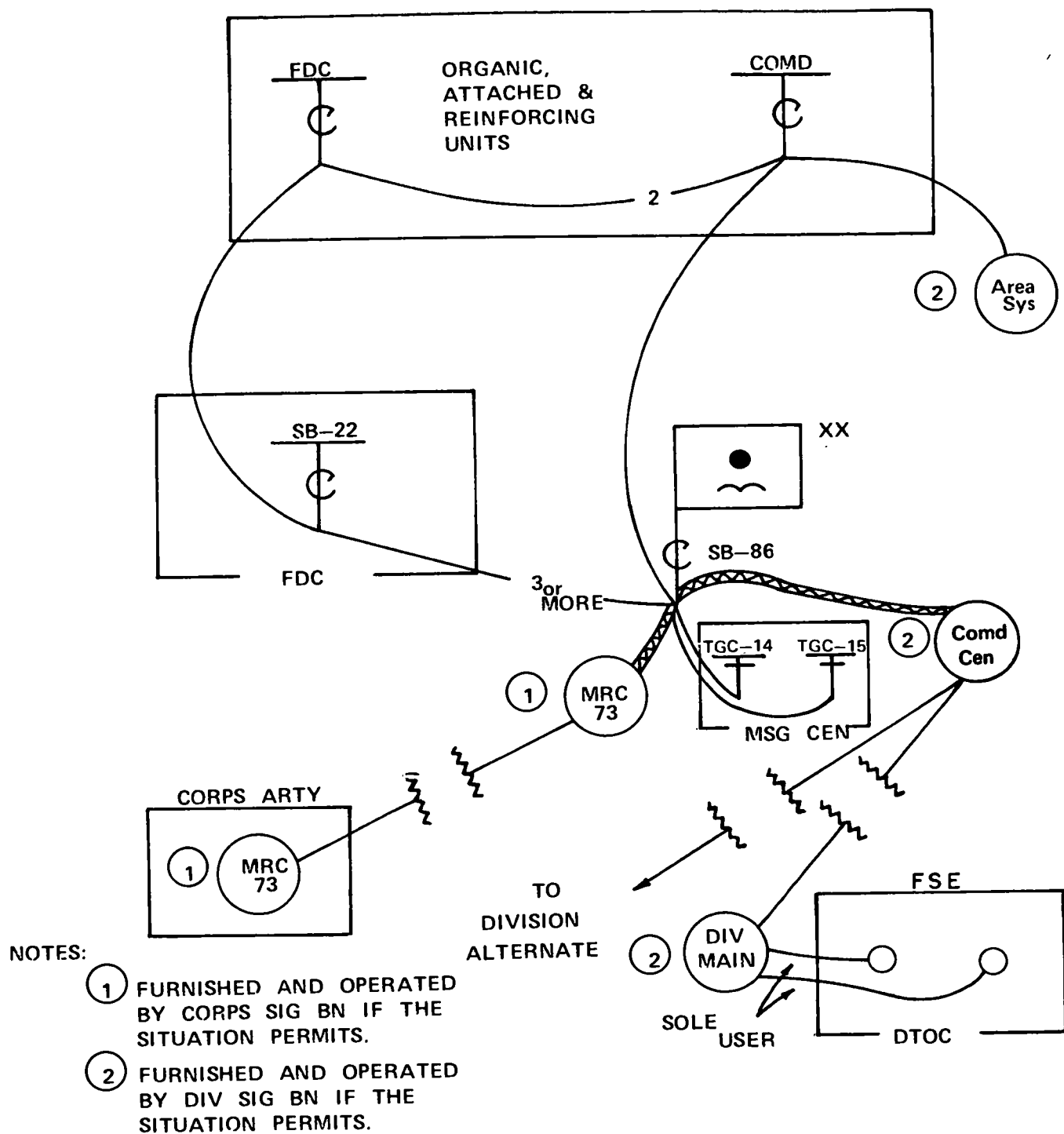
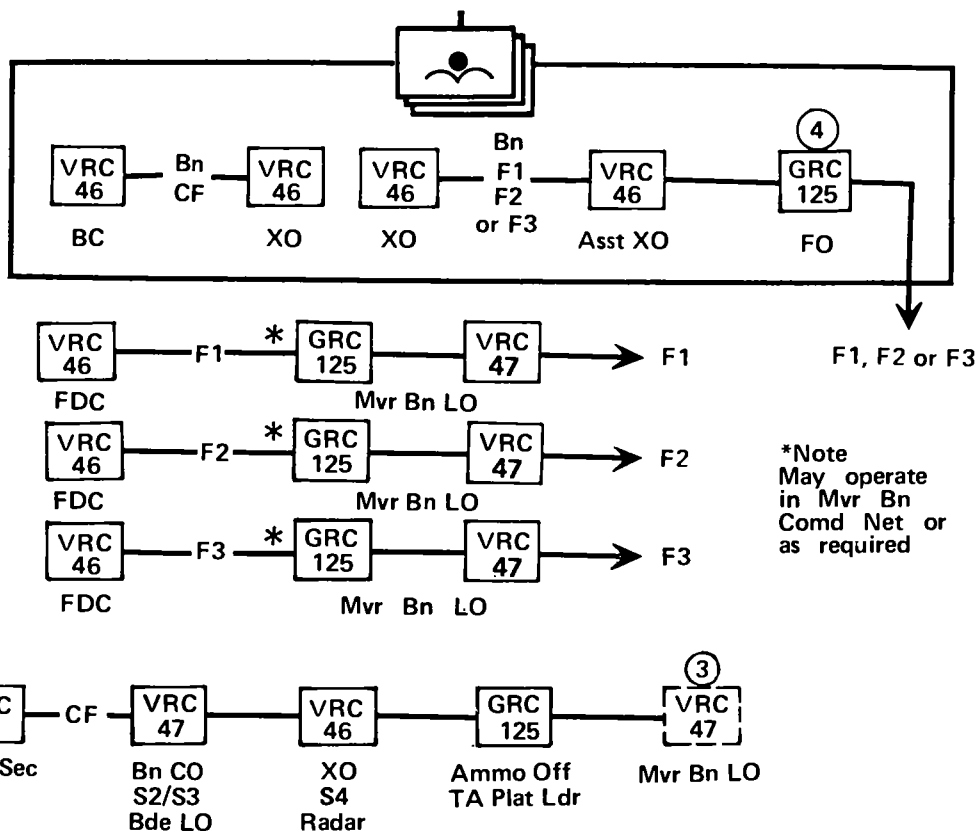


Figure 107. Wire and VHF system, HHB, airborne division artillery, TOE 6-201G.

4 GRR-5
20 GRC-125
4 PRC-25
20 VRC-46
6 VRC-47
1 VRC-49
1 VSC-2



EXTERNAL NETS

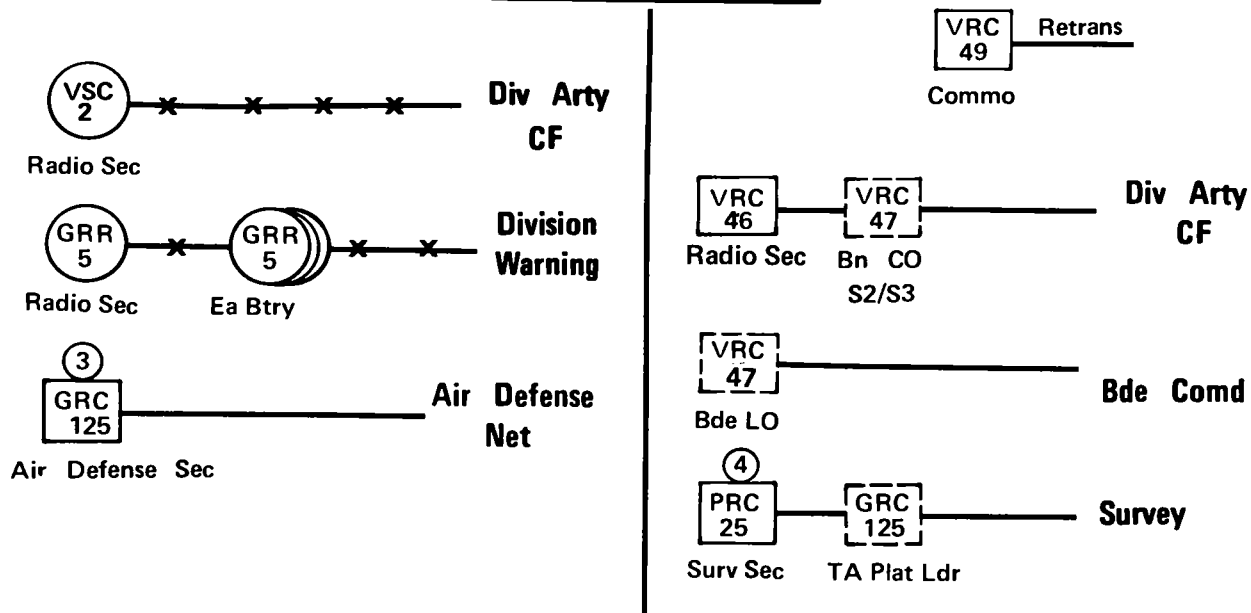
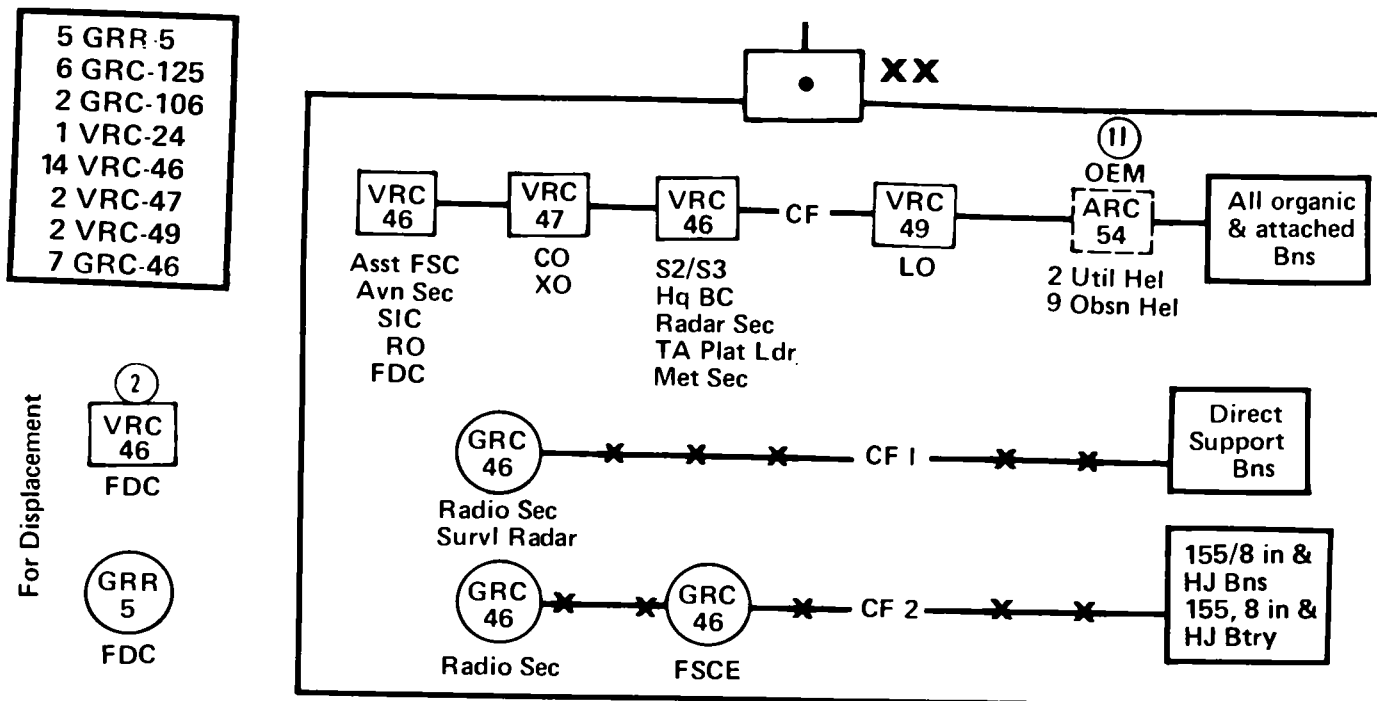
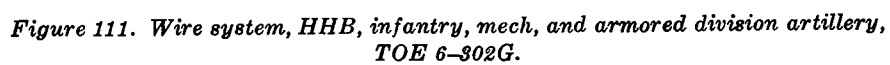
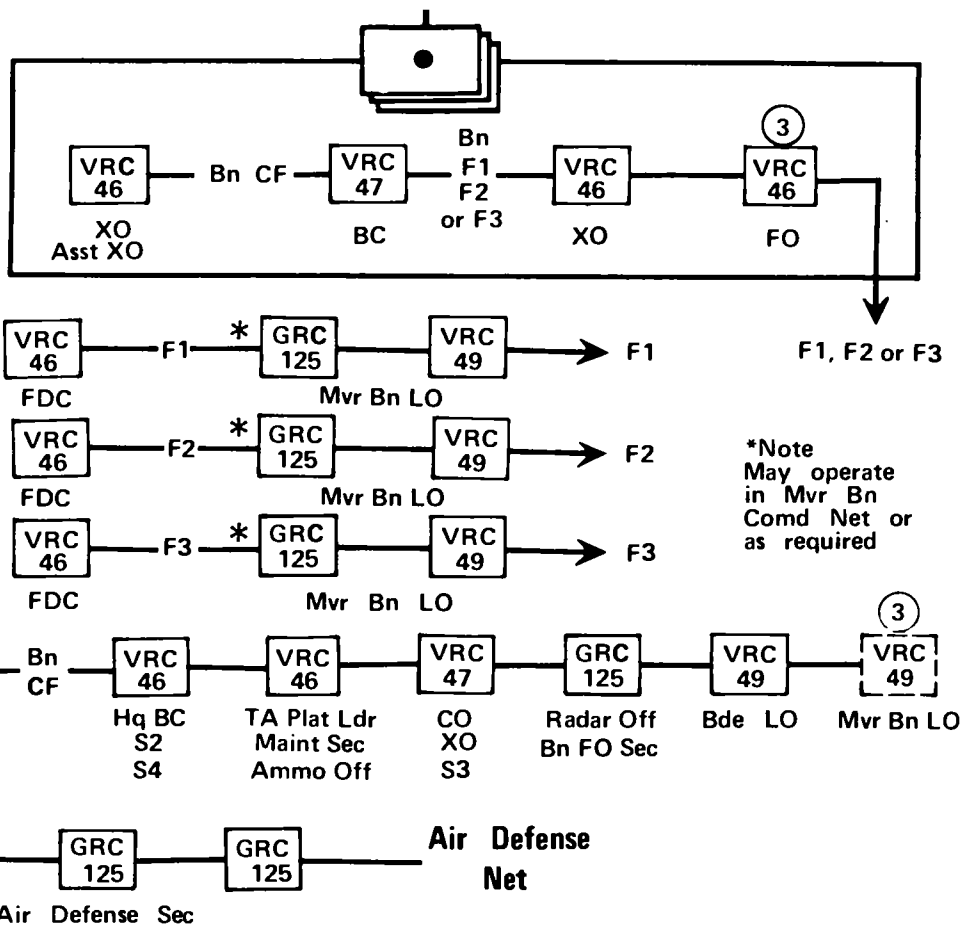


Figure 108. Radio nets, 105-mm battalion, airborne division artillery, TOE 6-215G.

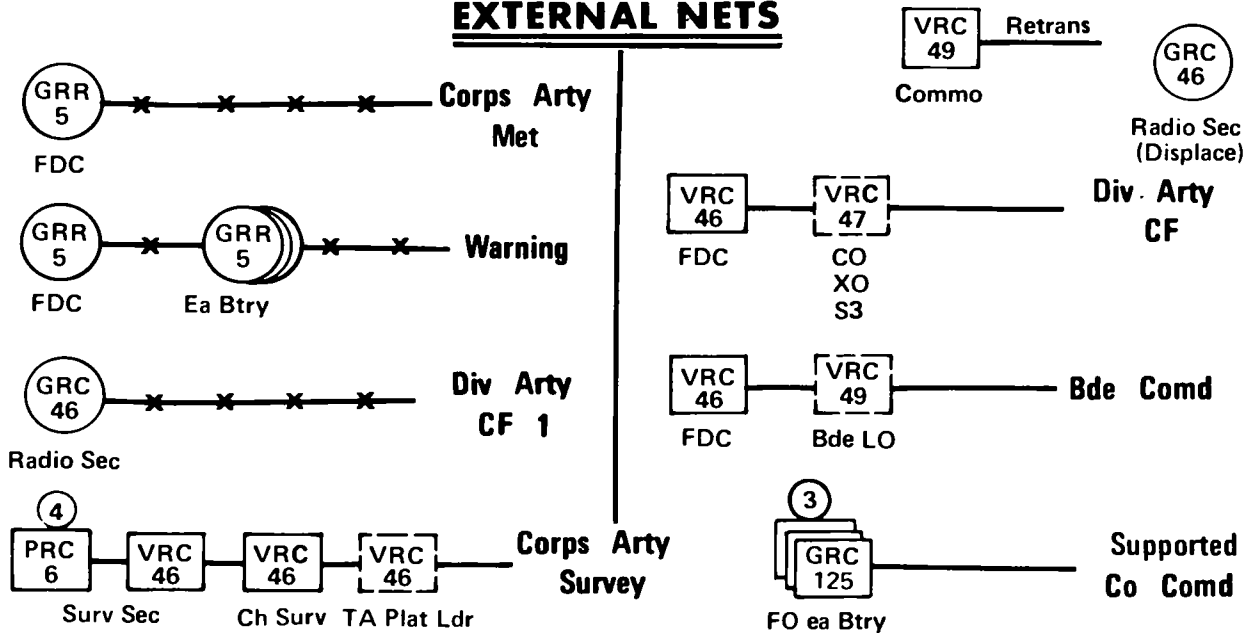




5 GRR-5
17 GRC-125
4 PRC-6
34 VRC-46
6 VRC-47
5 VRC-49
2 GRC-46



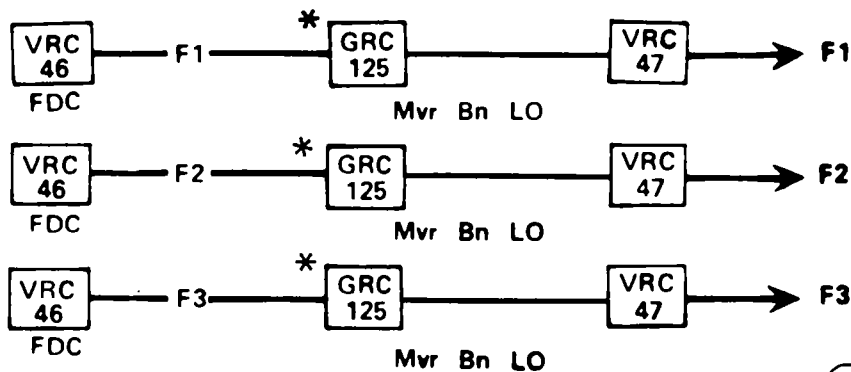
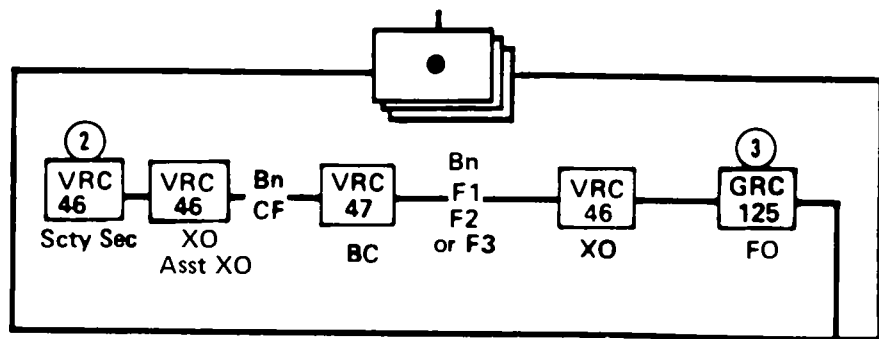
EXTERNAL NETS



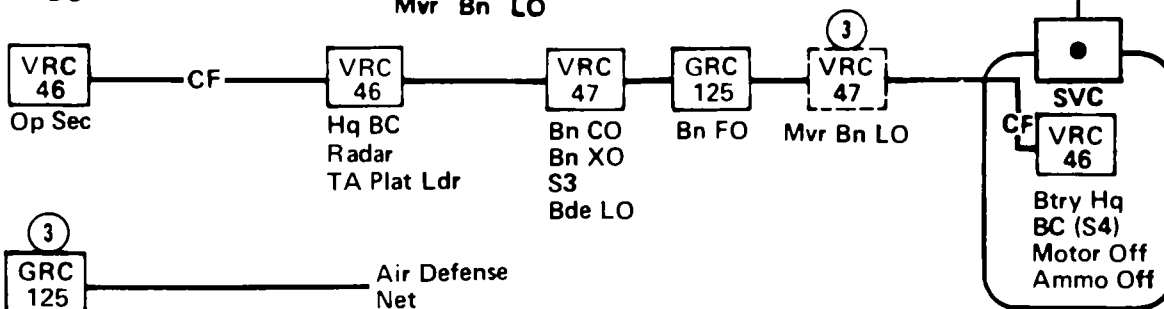
For Wire Diagram
see Fig 99

Figure 112. Radio nets, 105-mm battalion, SP, armored and mechanized division artillery, TOE 6-345G.

5	GRR 5
16	GRC 125
4	PRC 25
29	VRC 46
10	VRC 47
1	VRC 49
2	GRC 122

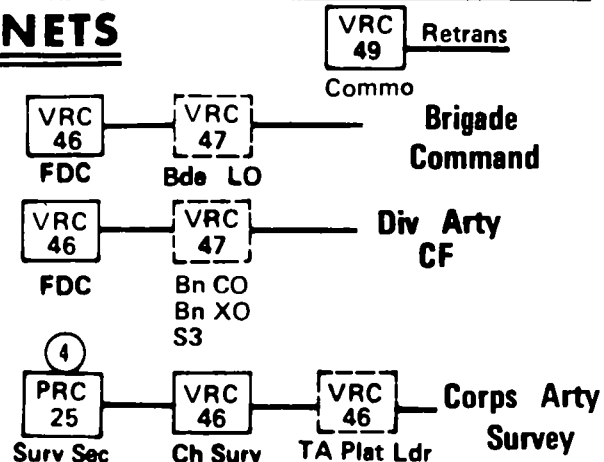
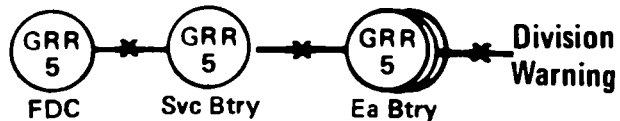
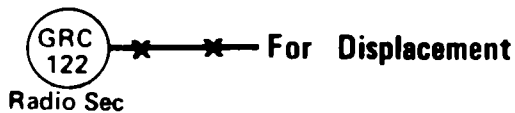
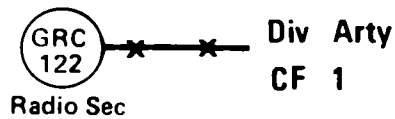


*Note
May operate in
maneuver Bn
Comd Net instead



Air Defense Sec

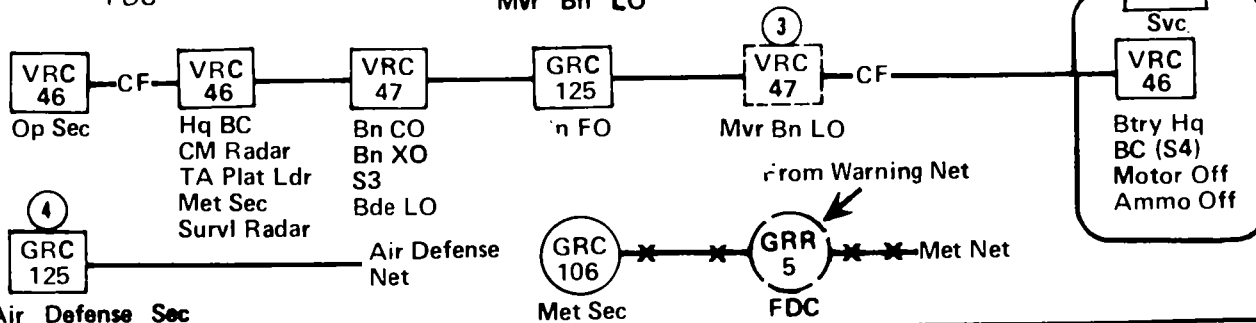
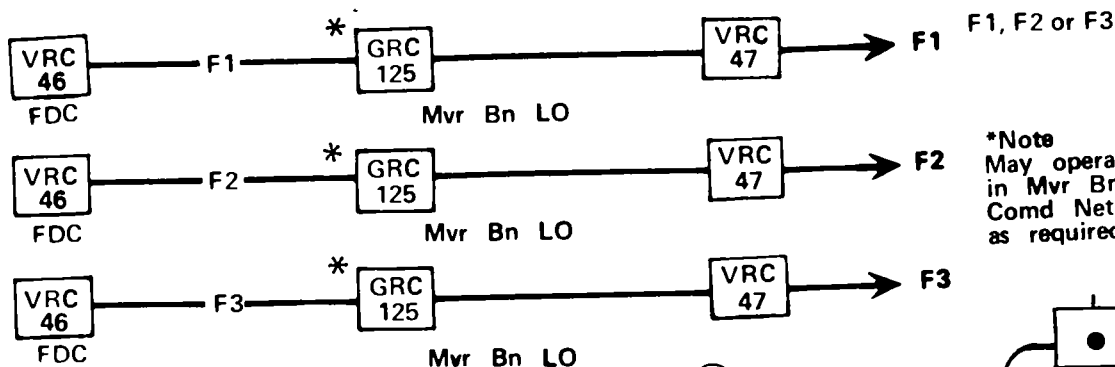
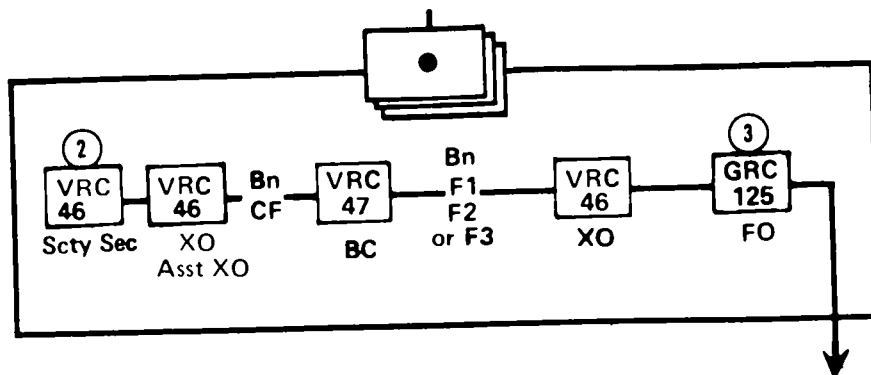
EXTERNAL NETS



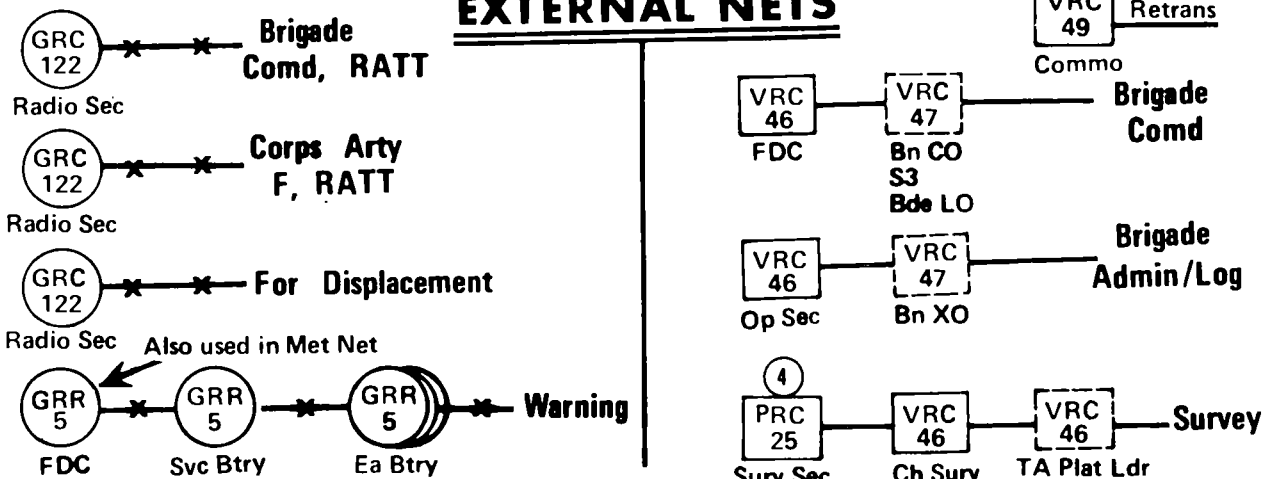
For Wire Diagram
see Fig 105

Figure 114. Radio nets, 155-mm DS battalion, armored and mechanized division artillery, TOE 6-365G.

5 GRR	5
17 GRC	125
1 GRC	106
4 PRC	25
31 VRC	46
10 VRC	47
1 VRC	49
3 GRC	122



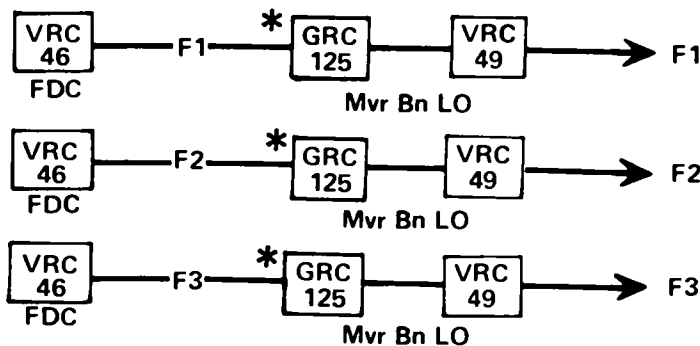
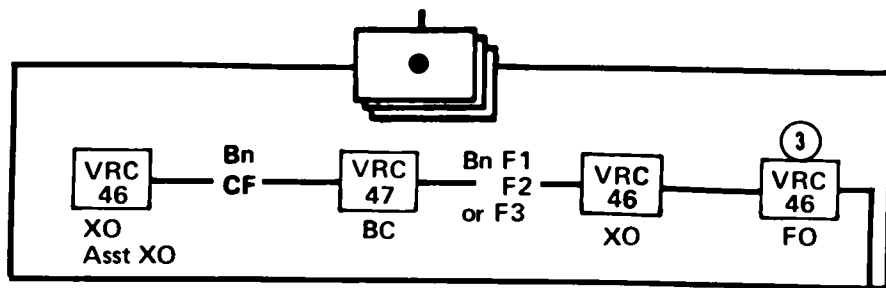
EXTERNAL NETS



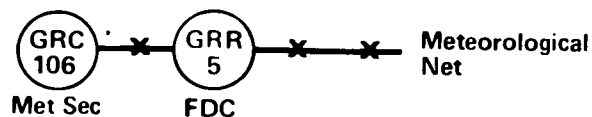
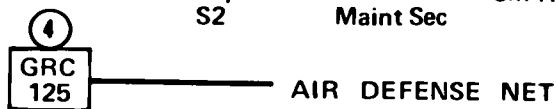
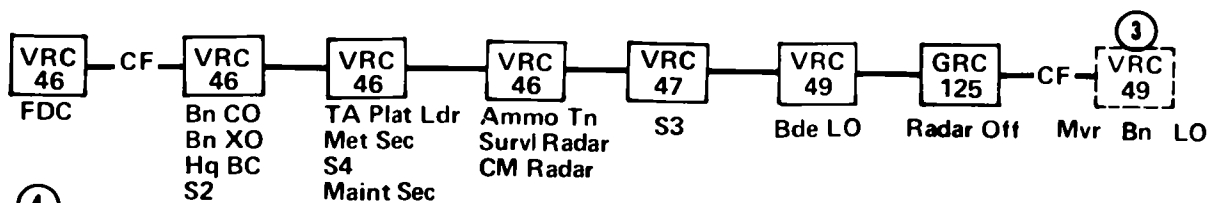
For Wire Diagram
see Fig 105

Figure 115. Radio nets, 155-mm battalion, SP, separate armored or mechanized brigade, TOE 6-375G.

5 GRR-	5
17 GRC-	125
1 GRC-	106
4 PRC-	6
38 VRC-	46
4 VRC-	47
5 VRC-	49
2 GRC-	46

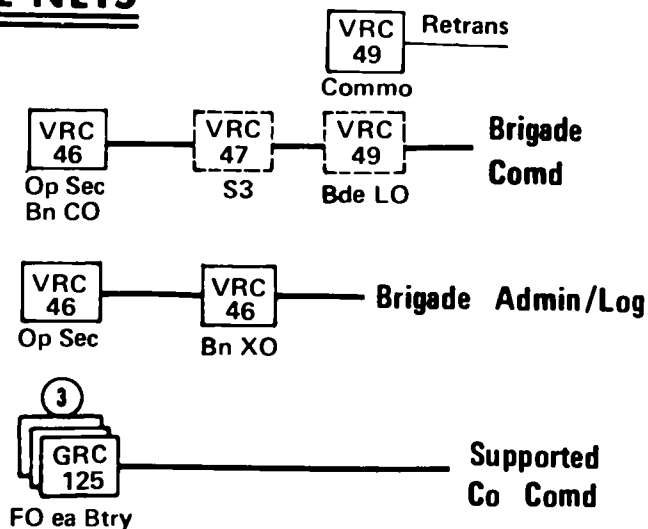
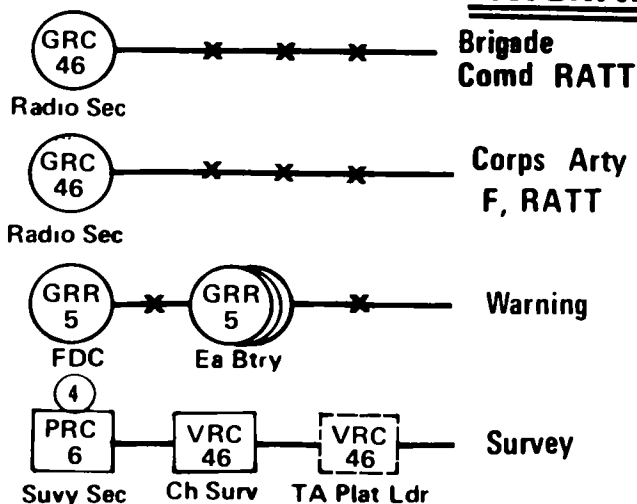


*Note
May operate in
maneuver Bn
Comd Net instead



Air Defense Sec

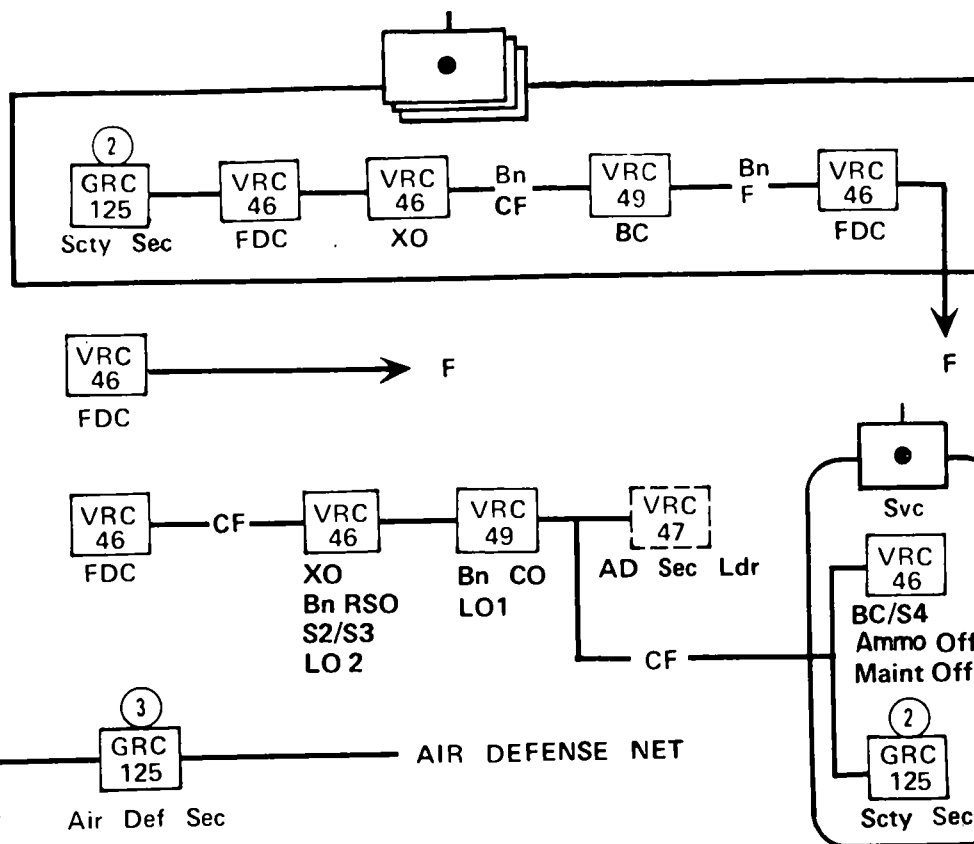
EXTERNAL NETS



For Wire Diagram
see Fig 105

Figure 116. Radio nets, 105-mm battalion, SP, separate armored or mechanized brigade, TOE 6-385G.

6 GRR-5
11 GRC-125
9 PRC-25
1 VRC-24
23 VRC-46
1 VRC-47
6 VRC-49
2 GRC-142



EXTERNAL NETS

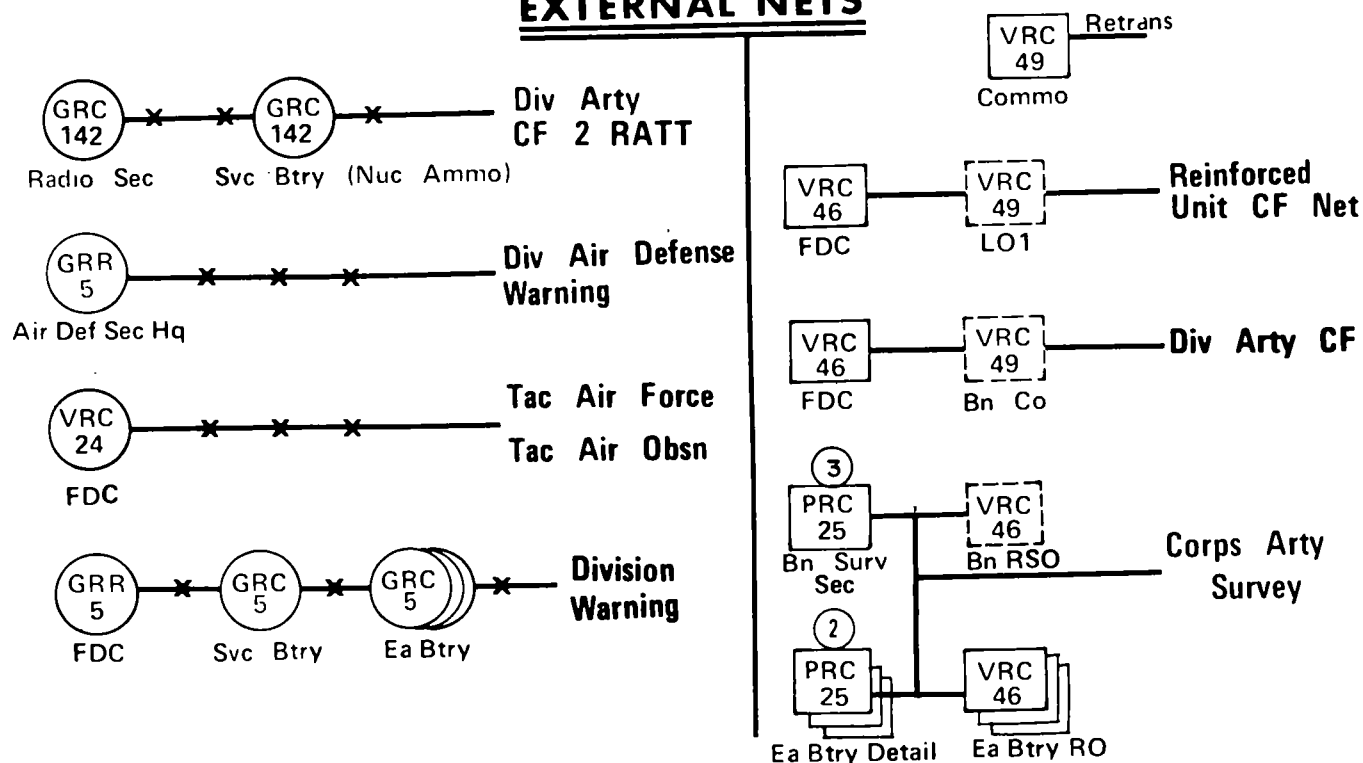


Figure 117. Radio nets, 8-inch battalion, SP, armored or mechanized division artillery, TOE 6-395G.

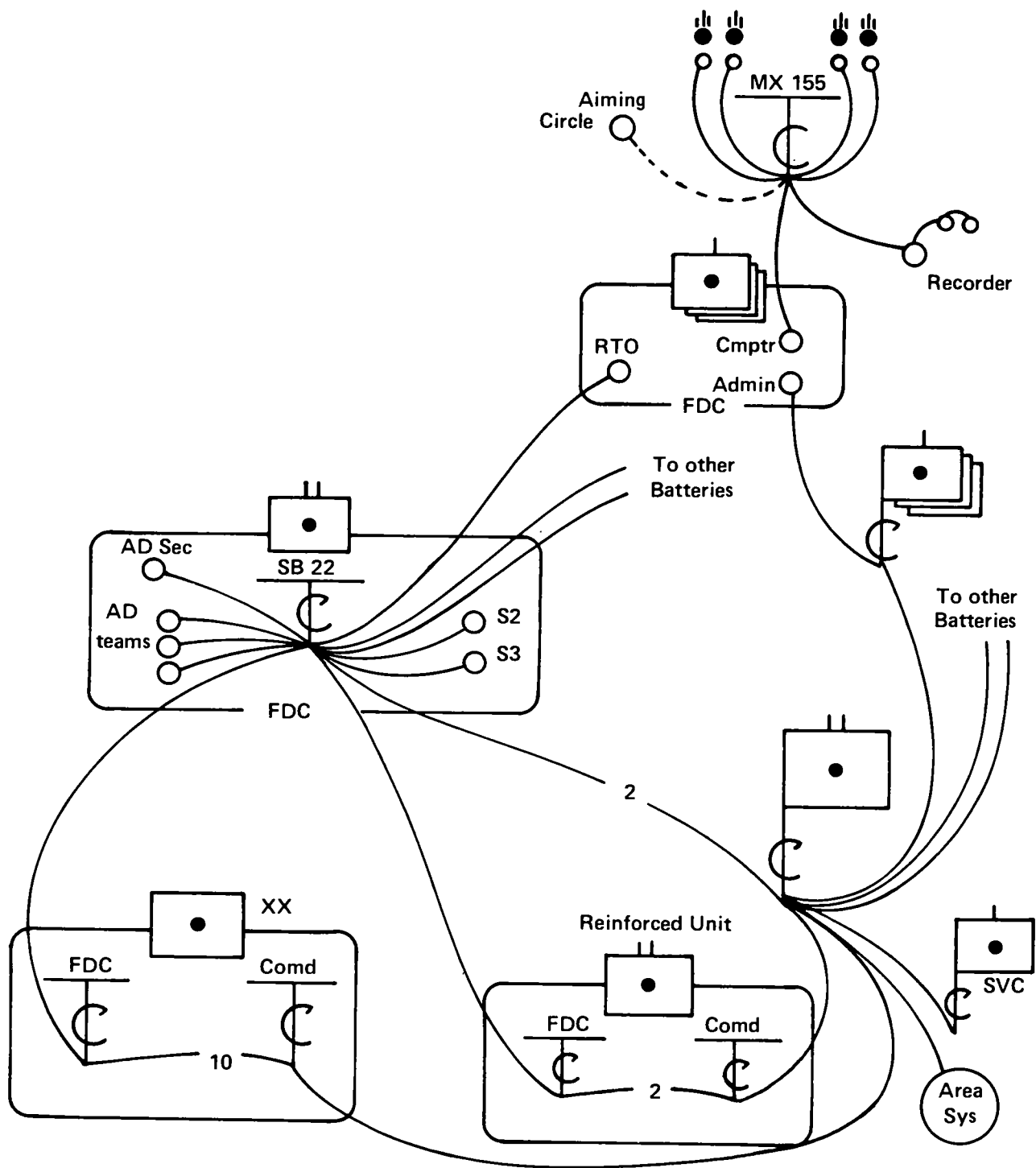


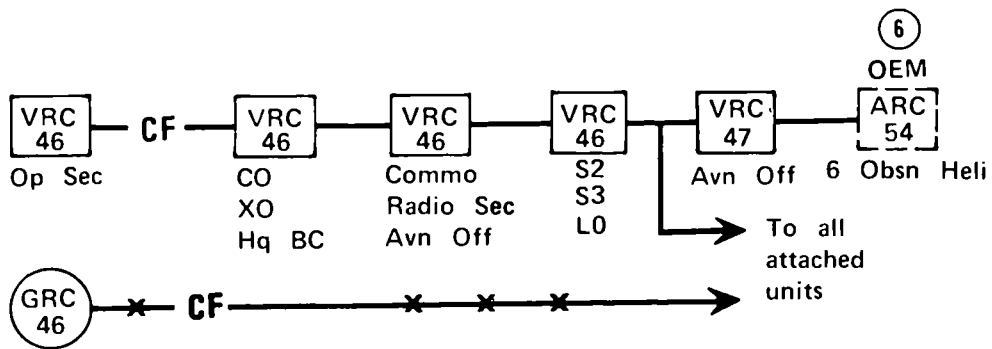
Figure 118. Wire system, 8-inch battalion, SP, armored or mechanized division artillery, TOE 6-395G.

- 2 GRR-5

13 VRC-46

1 VRC-47

3 GRC-46



EXTERNAL NETS

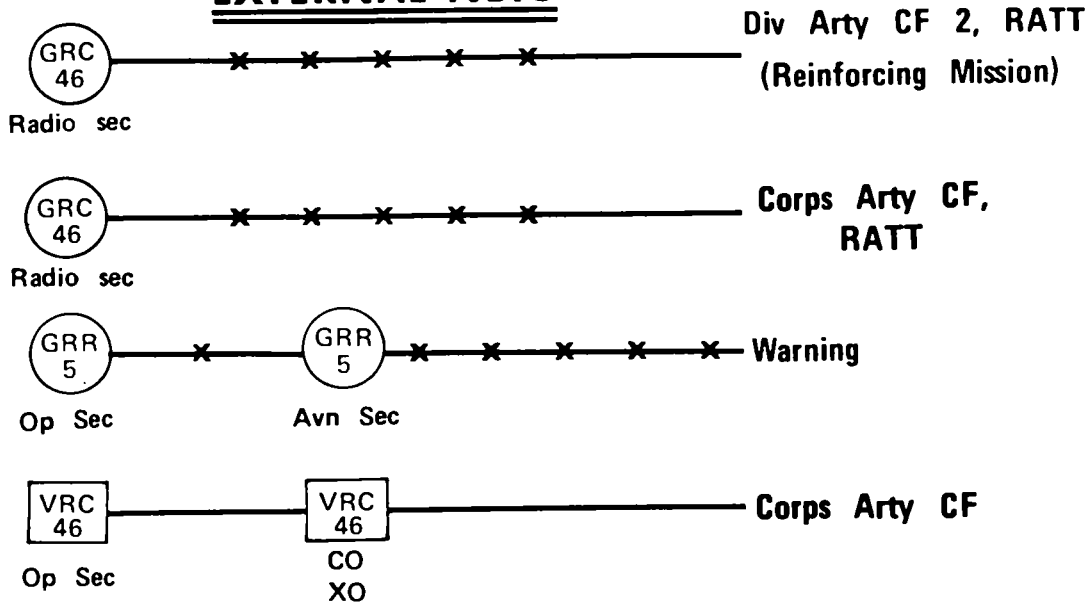


Figure 119. Radio nets, HHB, FA group, TOE 6-401G.

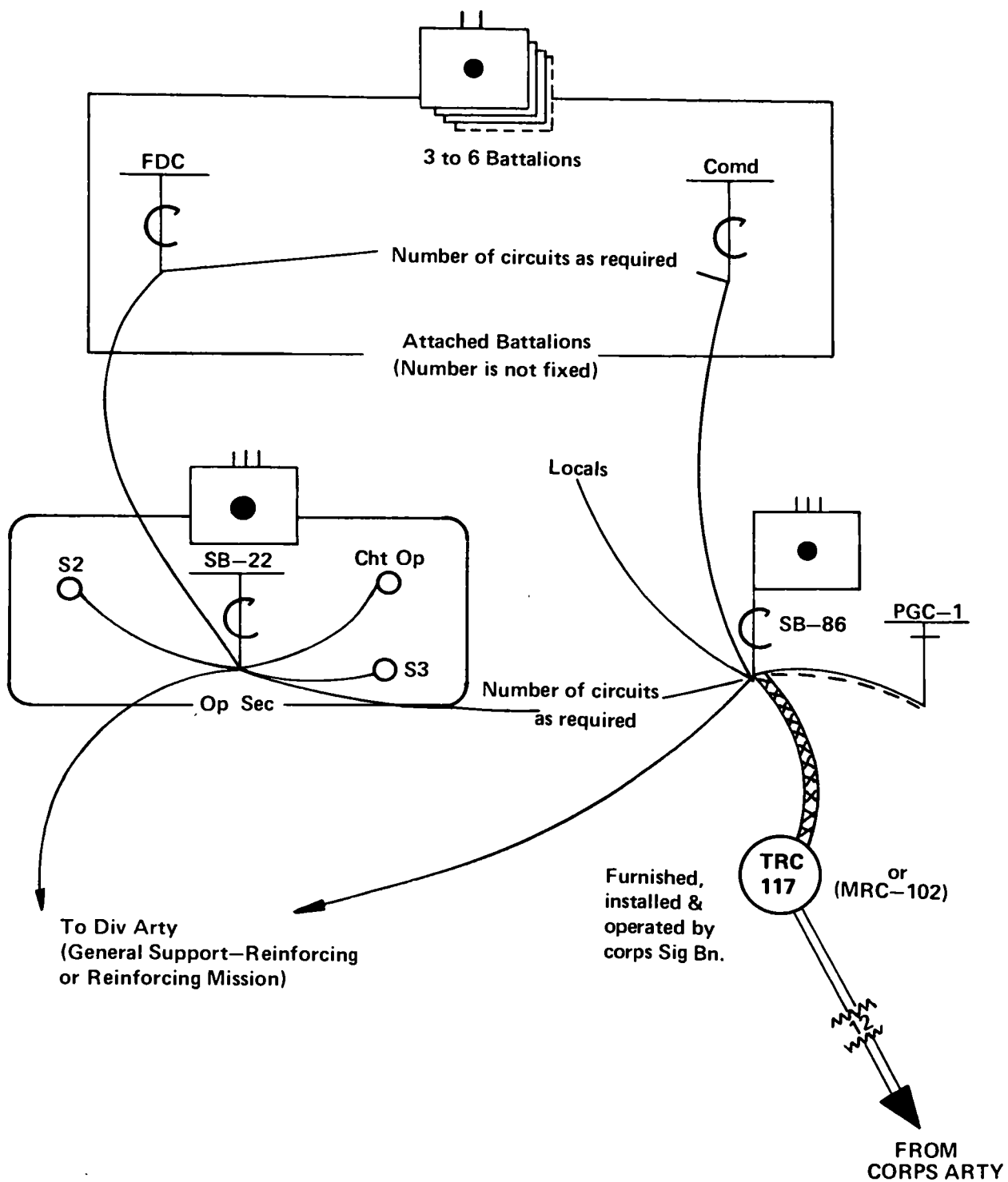


Figure 120. Wire system, HHB, FA group, TOE 6-401G.

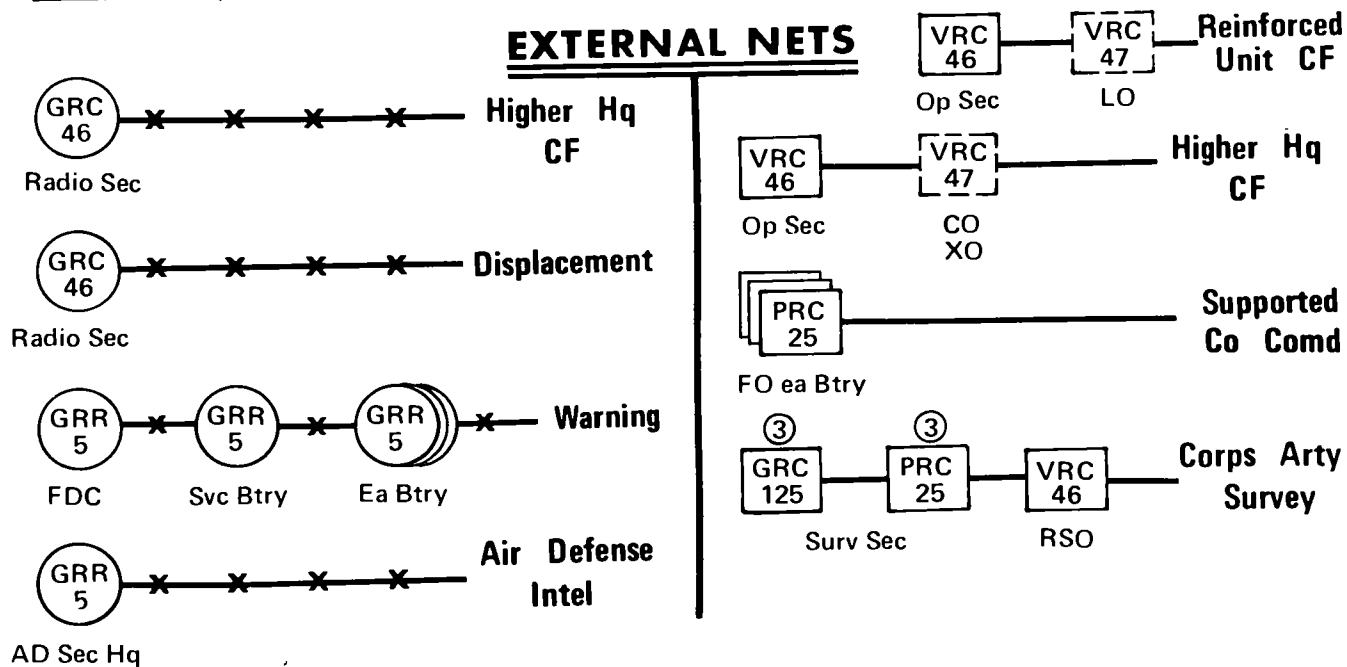
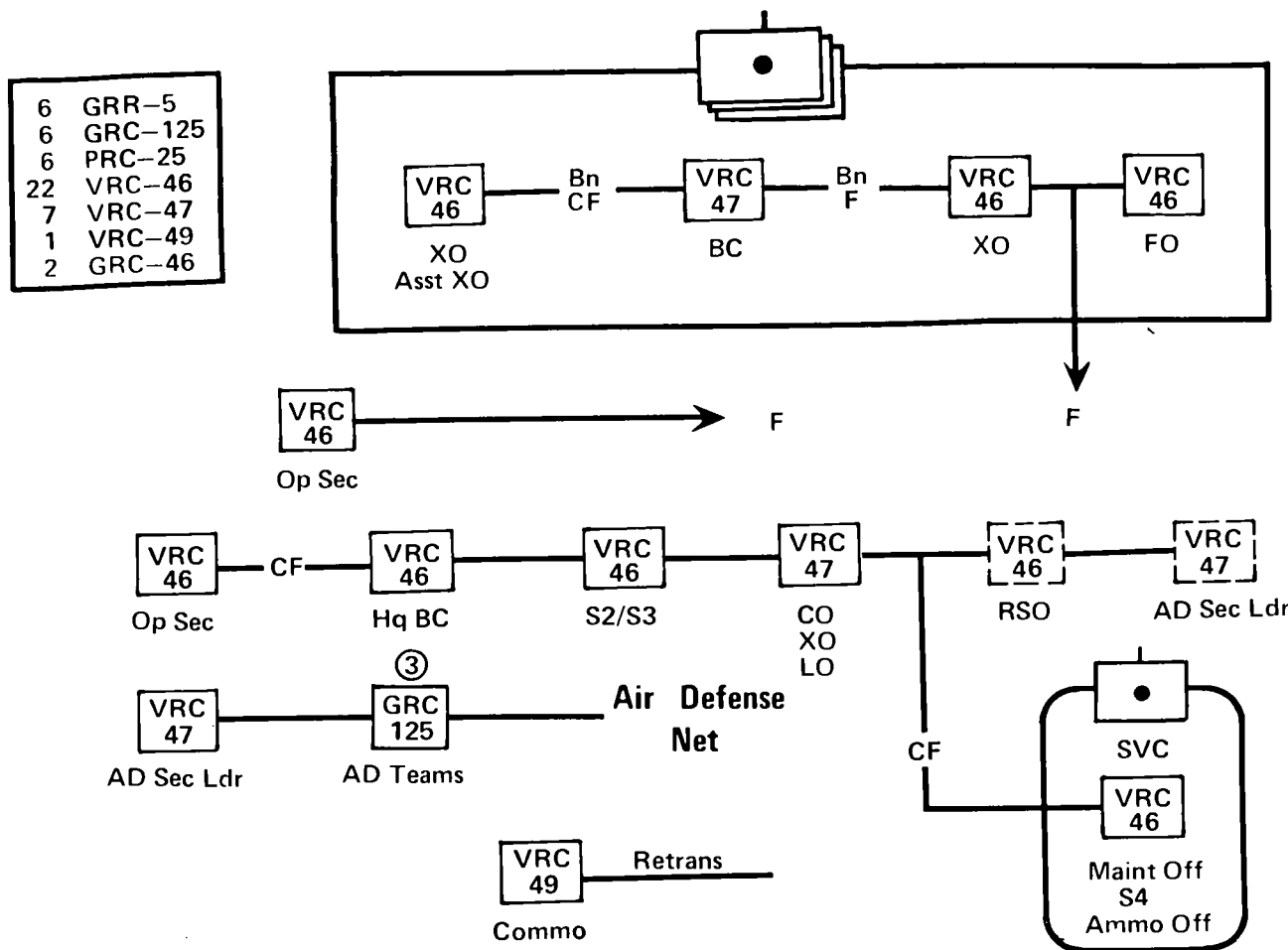


Figure 121. Radio nets, 105-mm battalion, towed, nondivisional, TOE 6-405G.

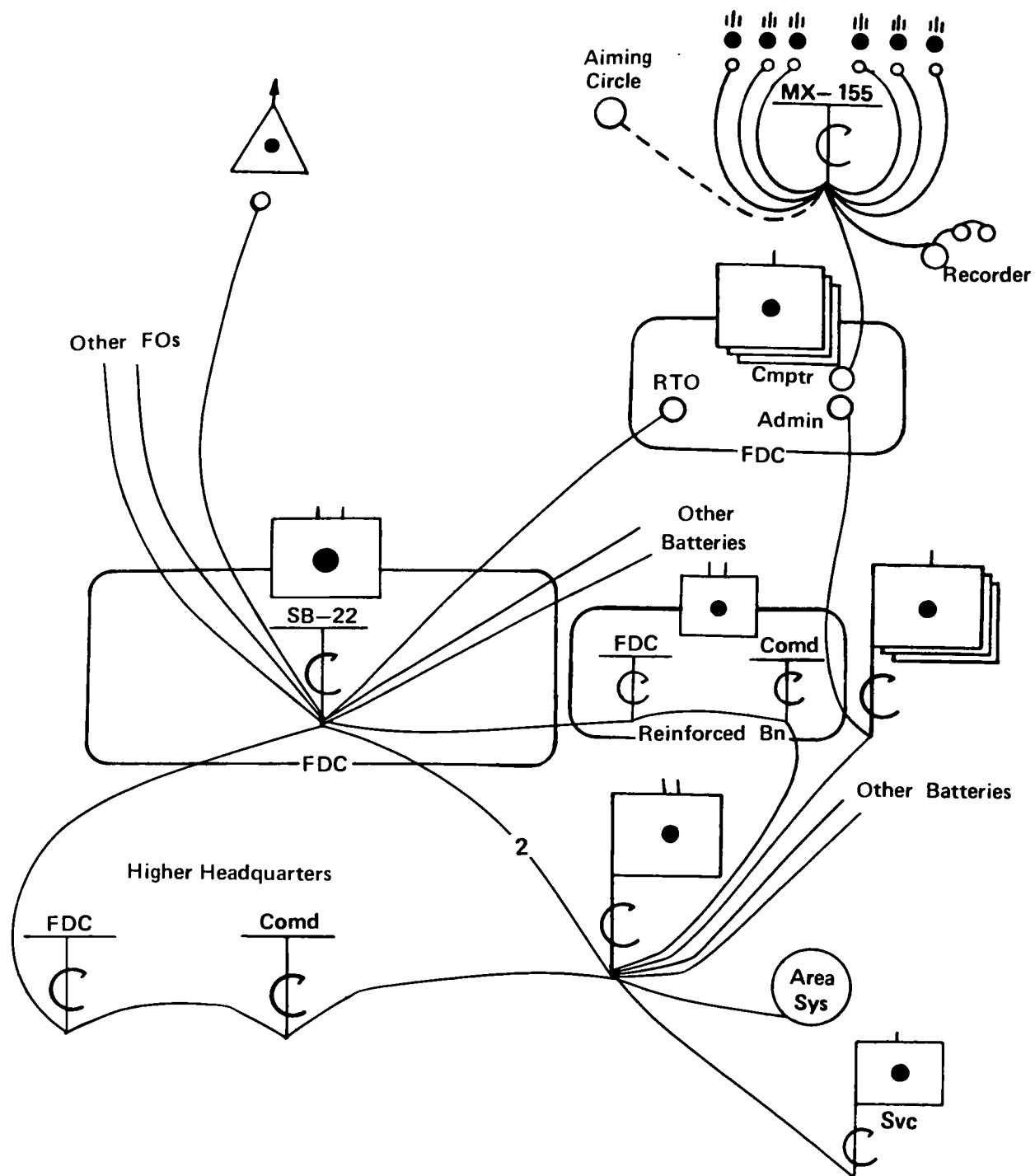
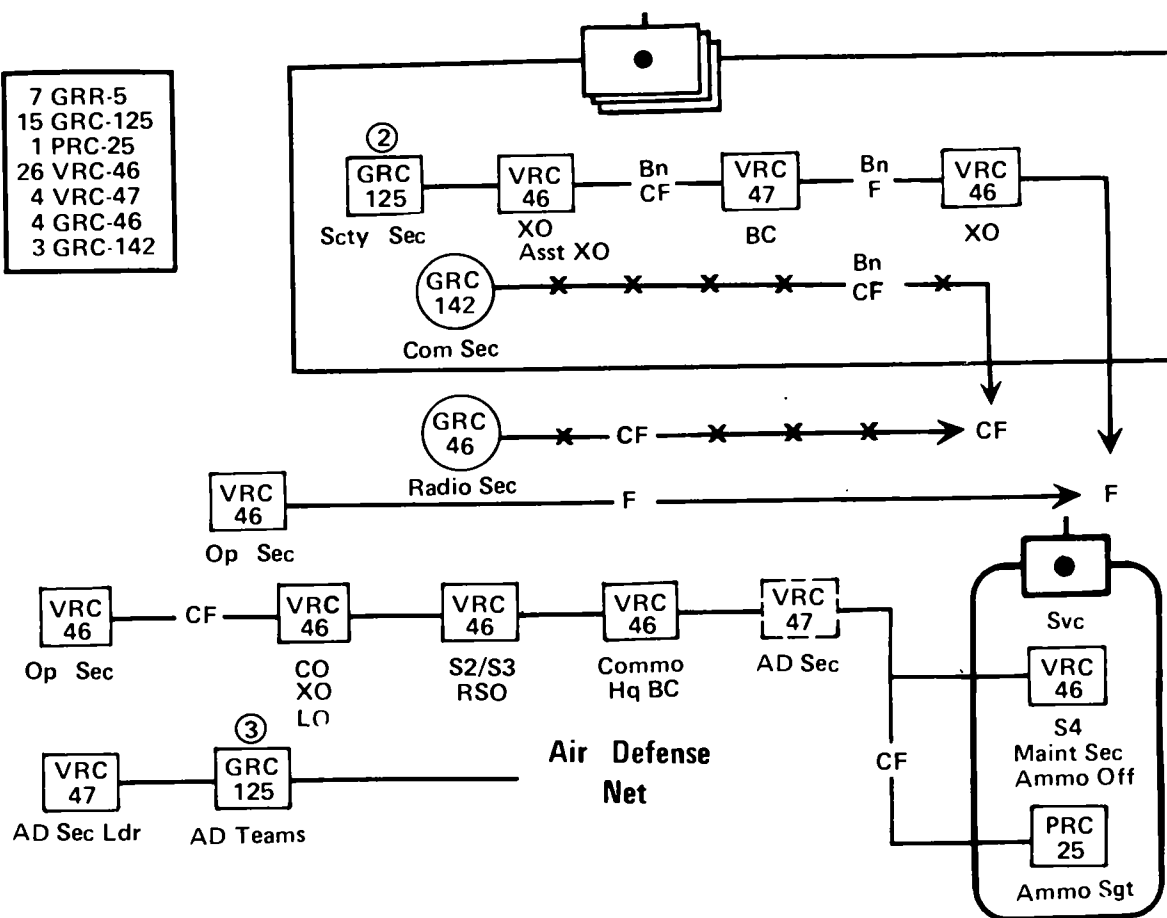
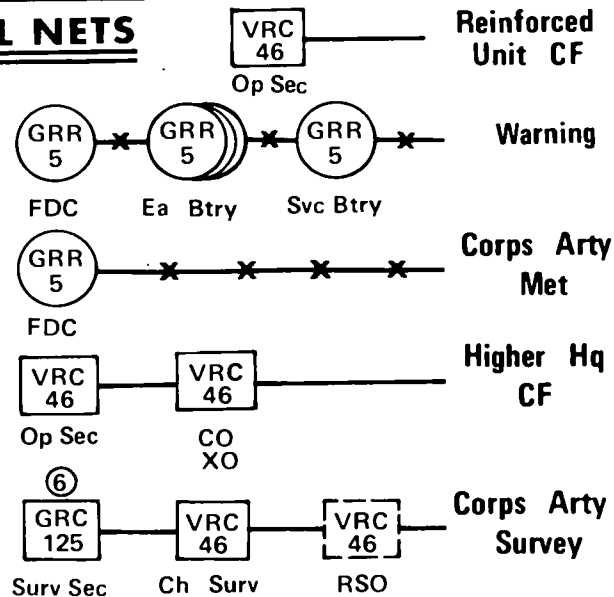
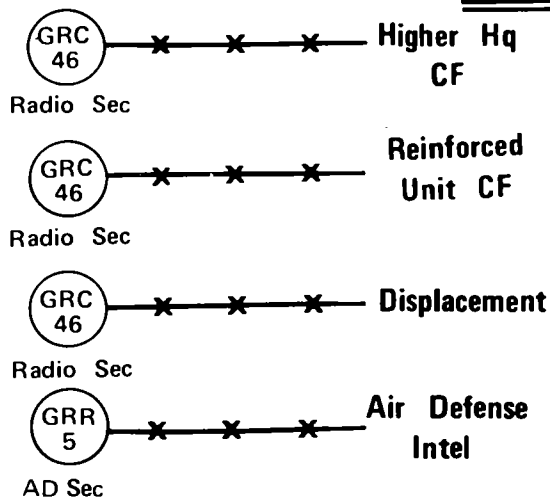


Figure 122. Wire system, 105-mm battalion, towed, nondivisional, TOE 6-405G.

7 GRR-5
15 GRC-125
1 PRC-25
26 VRC-46
4 VRC-47
4 GRC-46
3 GRC-142

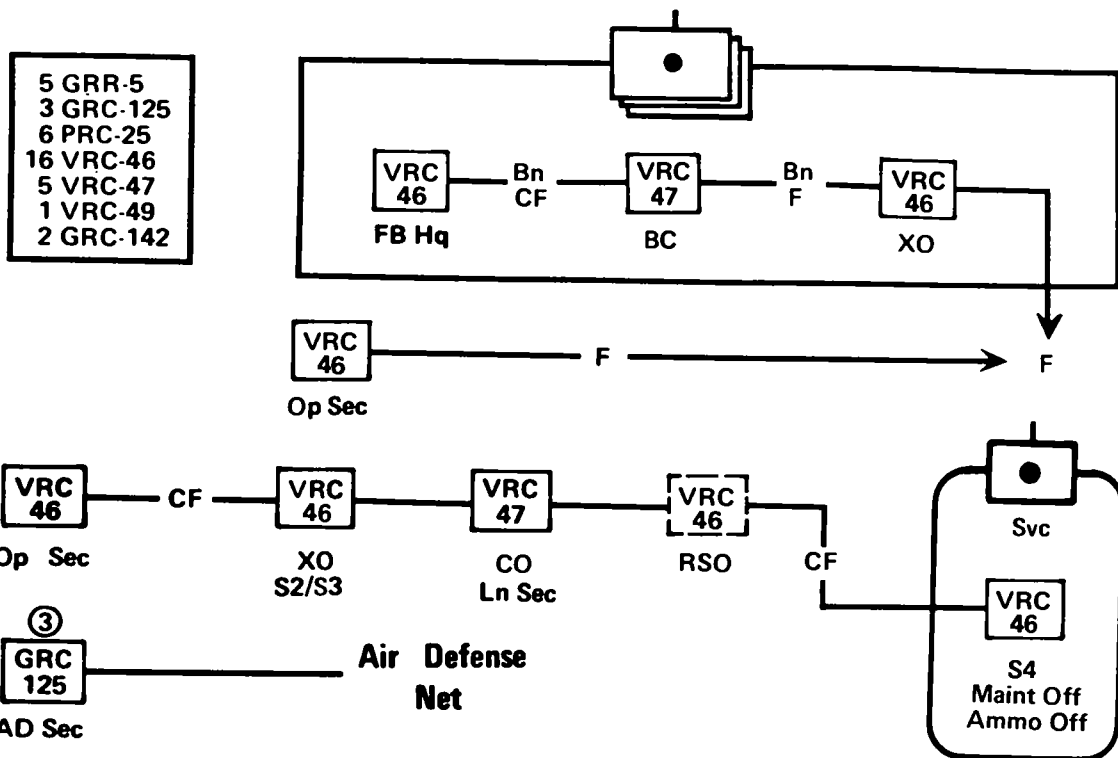


EXTERNAL NETS



For Wire Diagram
see Fig 129

Figure 123. Radio nets, 8-inch battalion, towed, TOE 6-415G.



EXTERNAL NETS

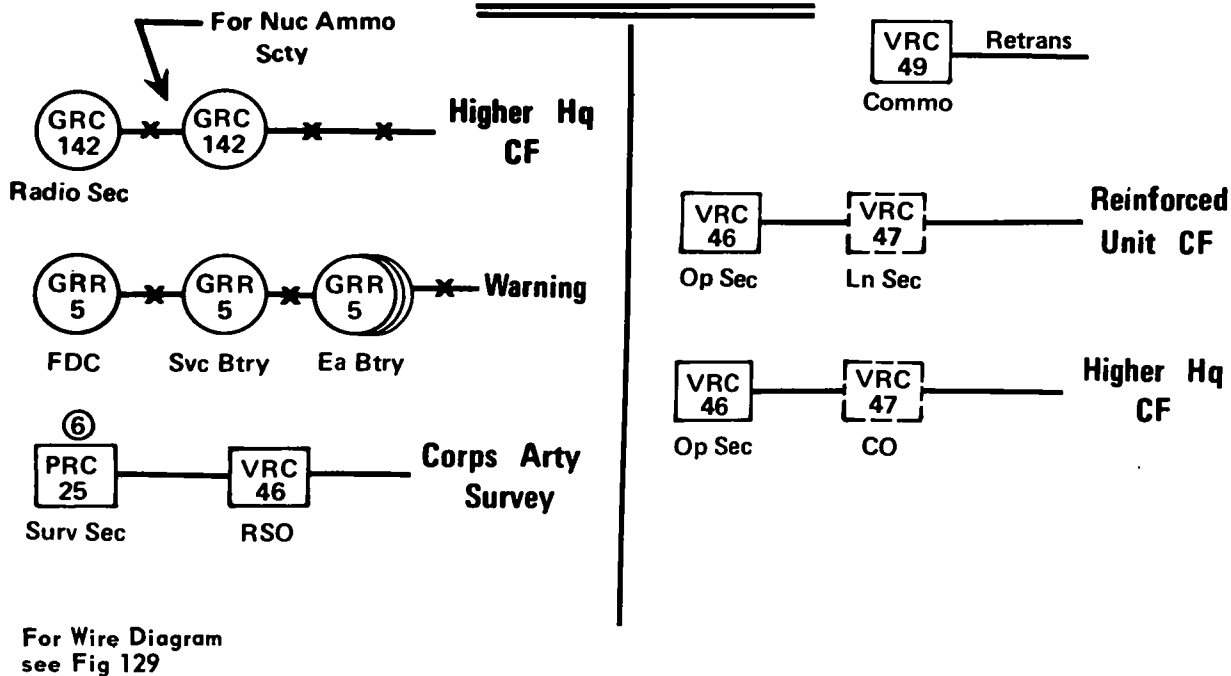
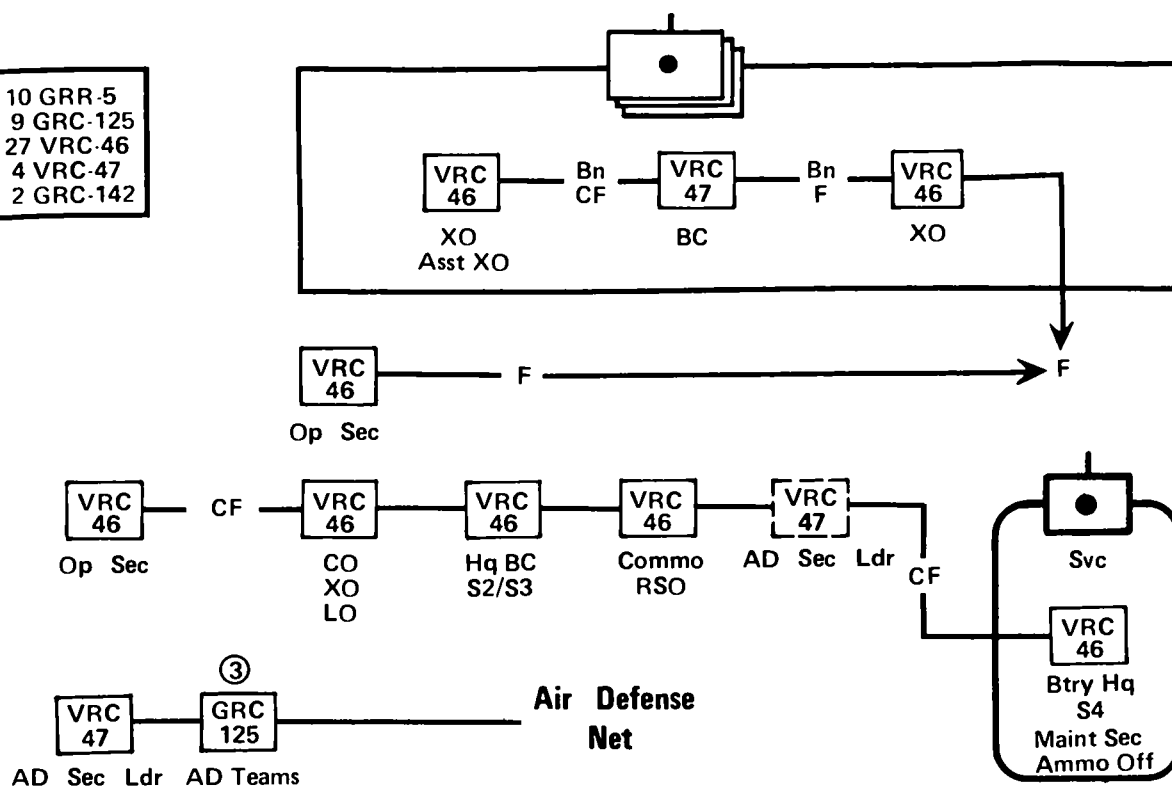
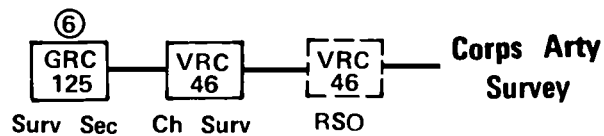
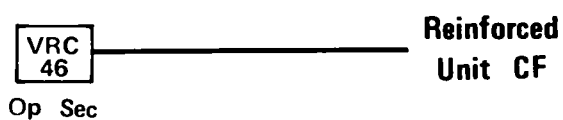
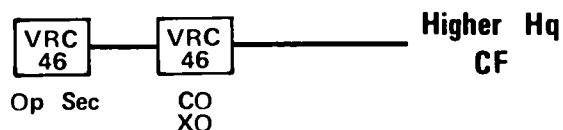
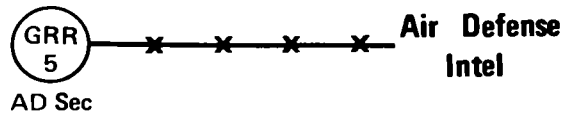
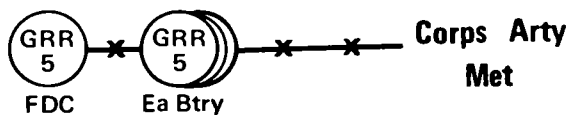
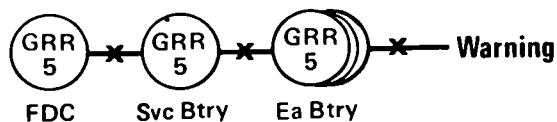
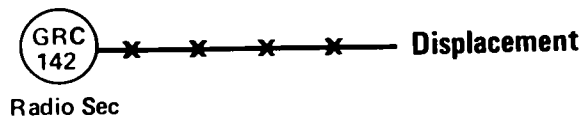
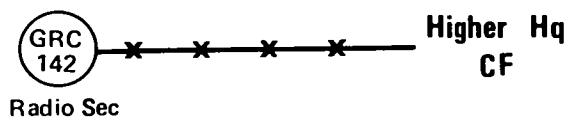


Figure 124. Radio nets, 155-mm battalion, towed, TOE 6-425G.

10 GRR-5
9 GRC-125
27 VRC-46
4 VRC-47
2 GRC-142

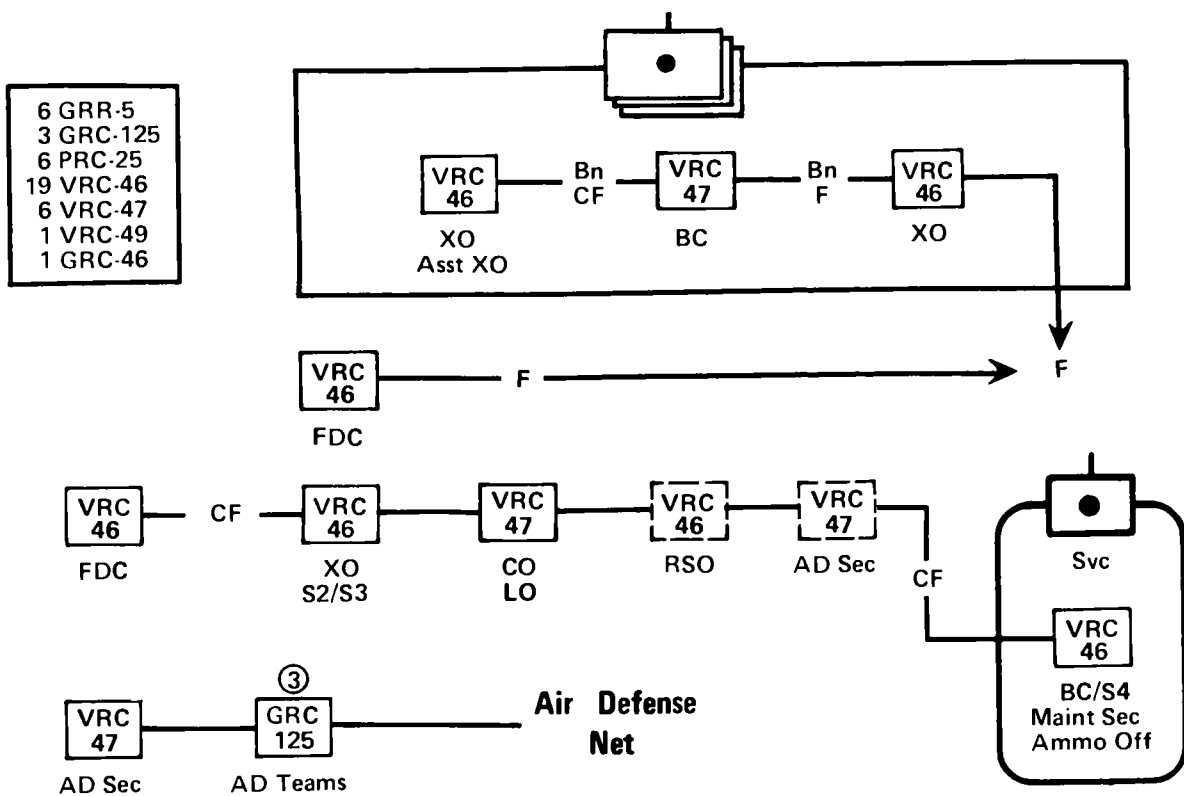


EXTERNAL NETS



For Wire Diagram
see Fig 129

Figure 125. Radio nets, 175-mm battalion, SP, TOE 6-435G.



EXTERNAL NETS

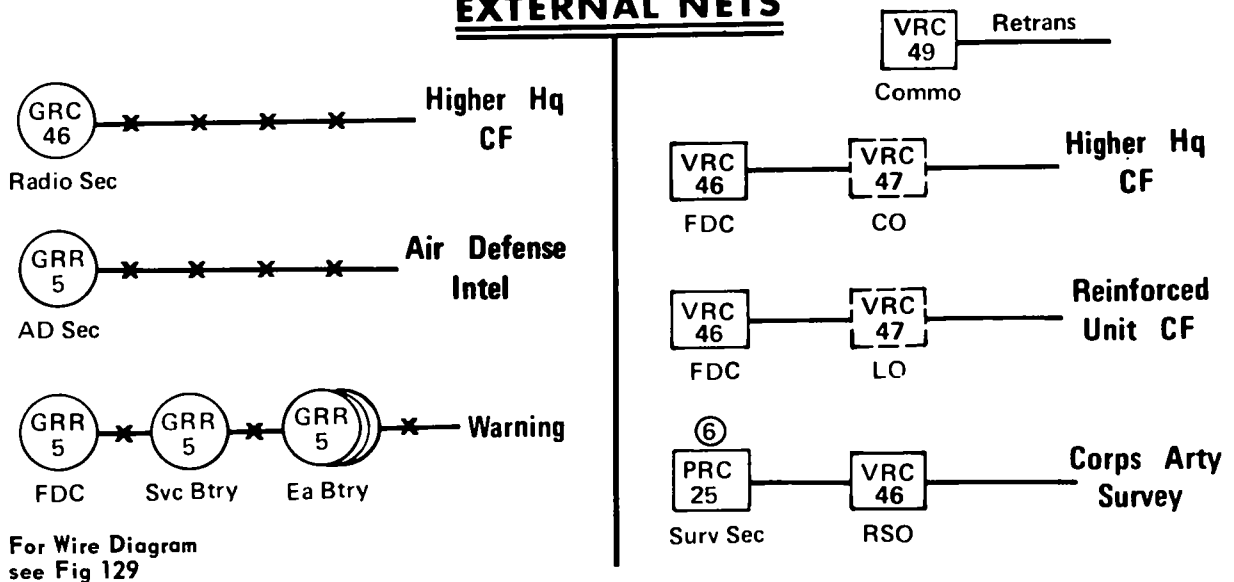
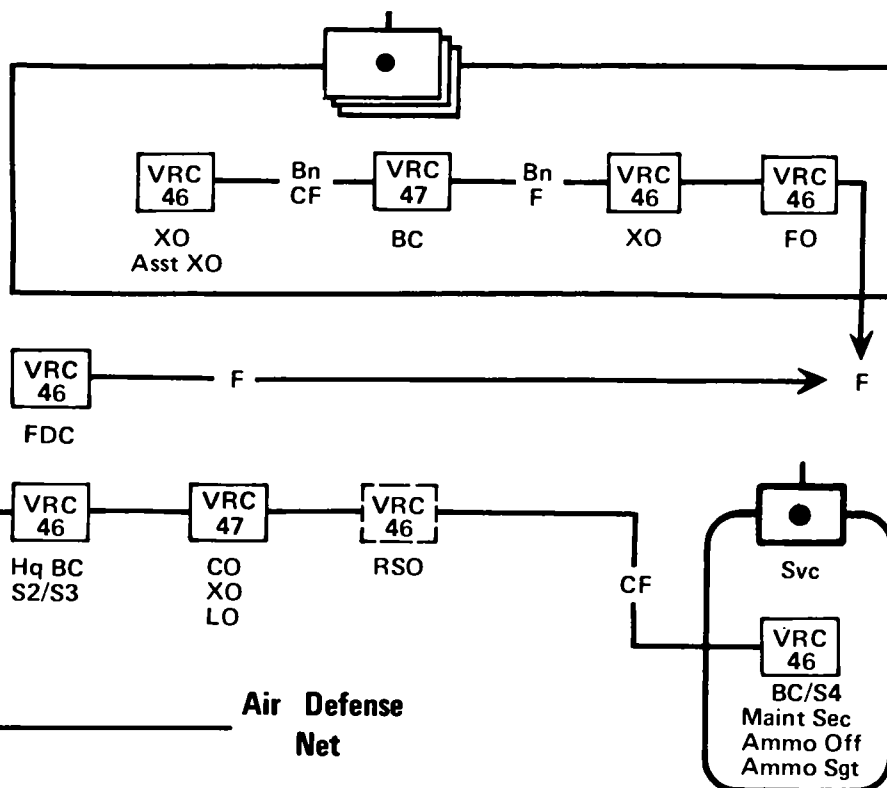
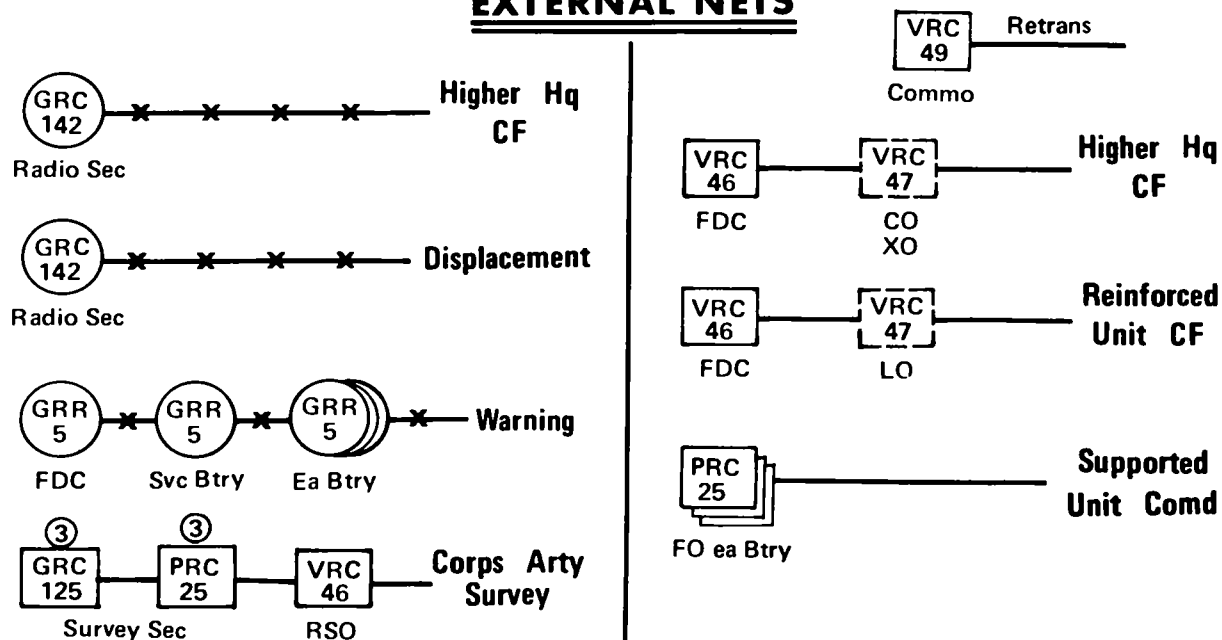


Figure 127. Radio nets, 155-mm battalion, SP, TOE 6-455G.

5 GRR-5
6 GRC-125
6 PRC-25
23 VRC-46
6 VRC-47
1 VRC-49
2 GRC-142



EXTERNAL NETS



For Wire Diagram
see Fig 129

Figure 128. Radio nets, 105-mm battalion, SP, TOE 6-465G.

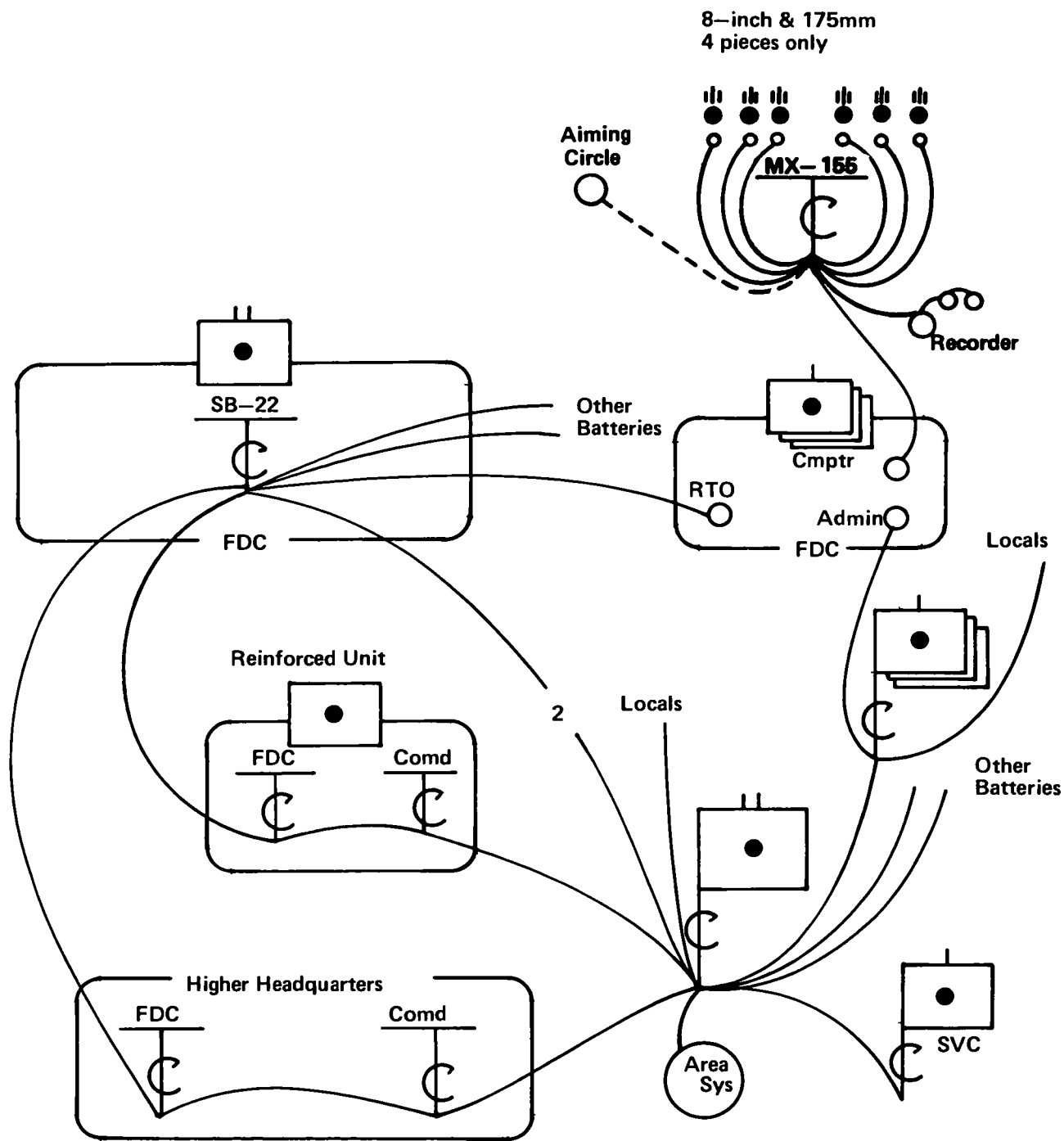


Figure 129. Wire system, nondivisional general support battalions, TOE 6-415G, 6-425G, 6-435G, 6-445G, 6-455G, 6-465G.

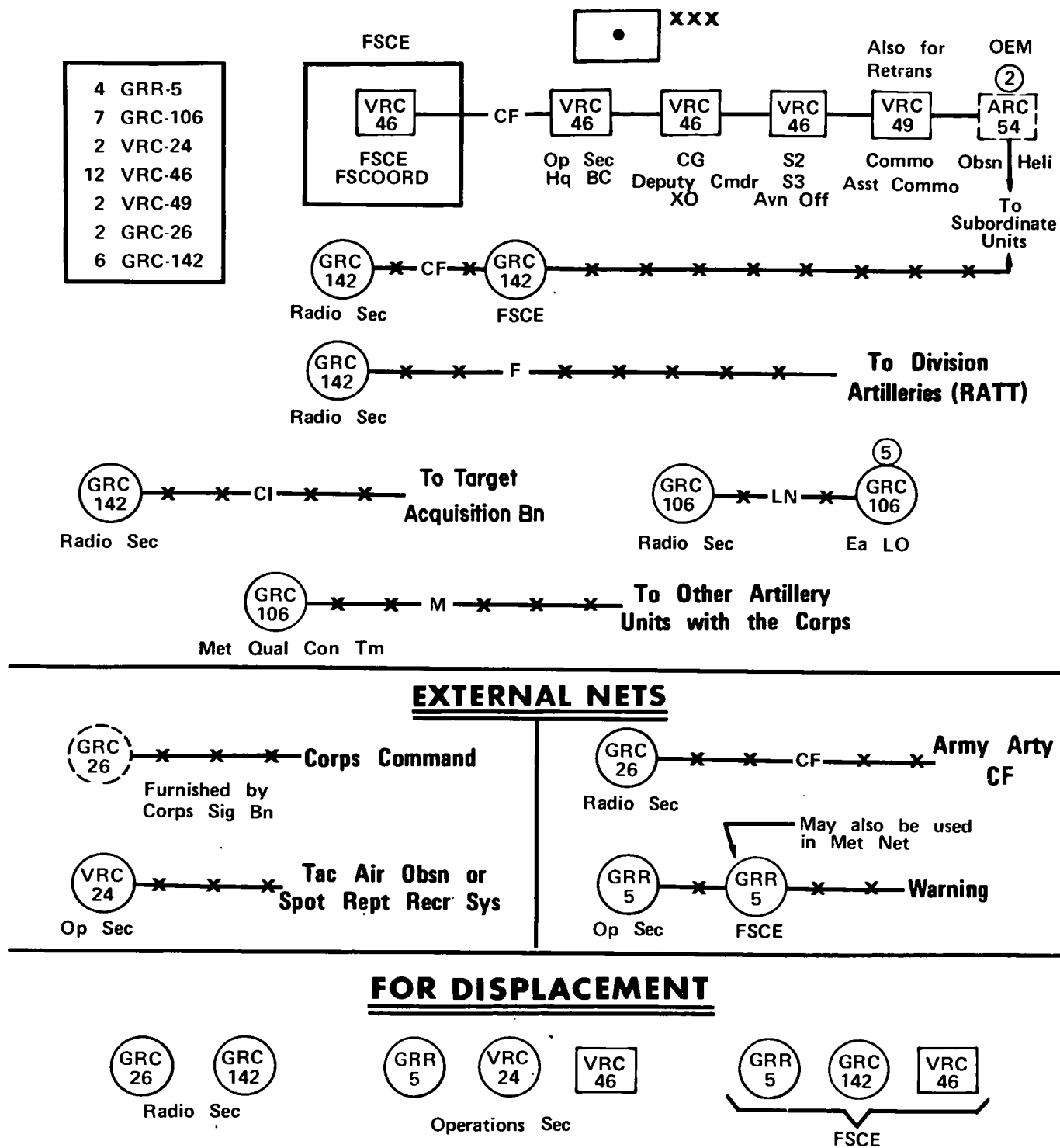
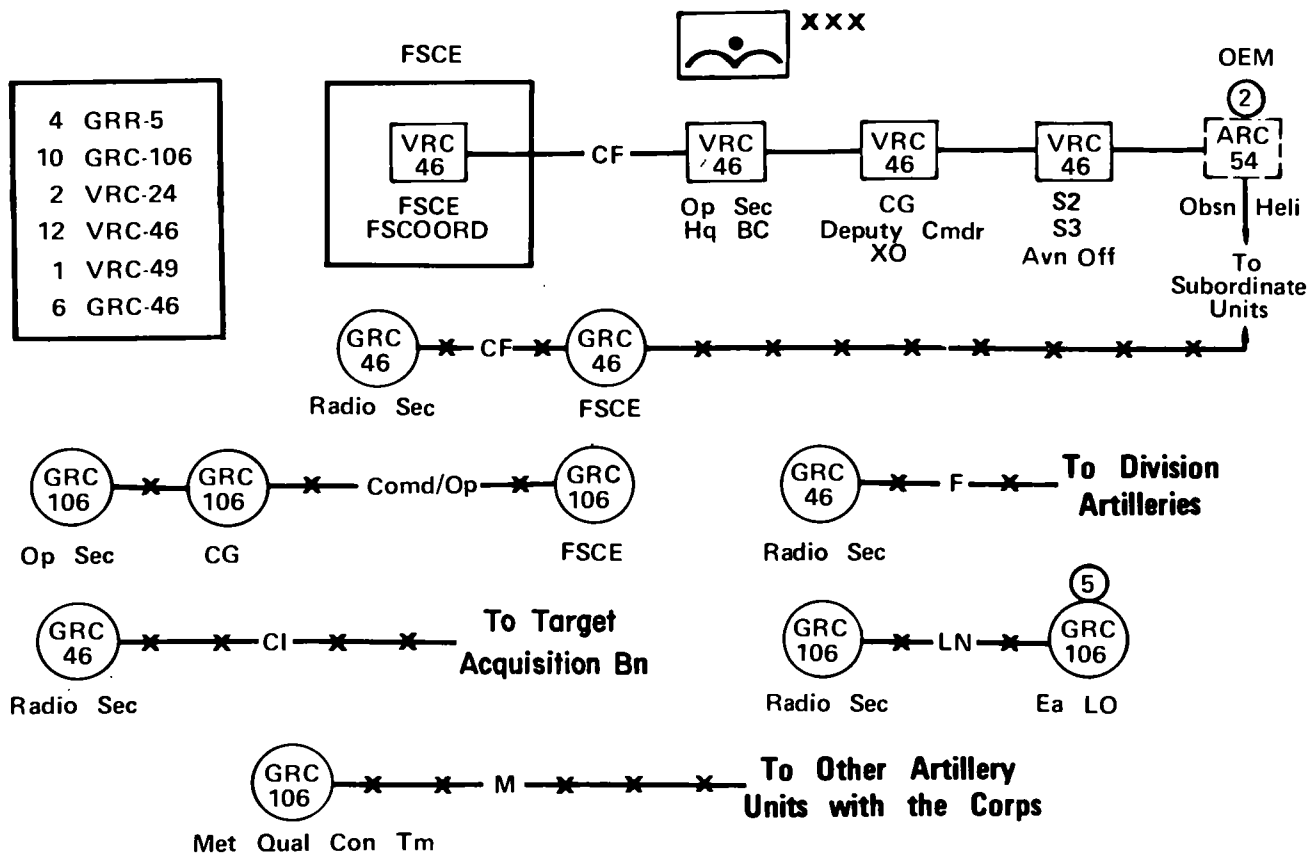
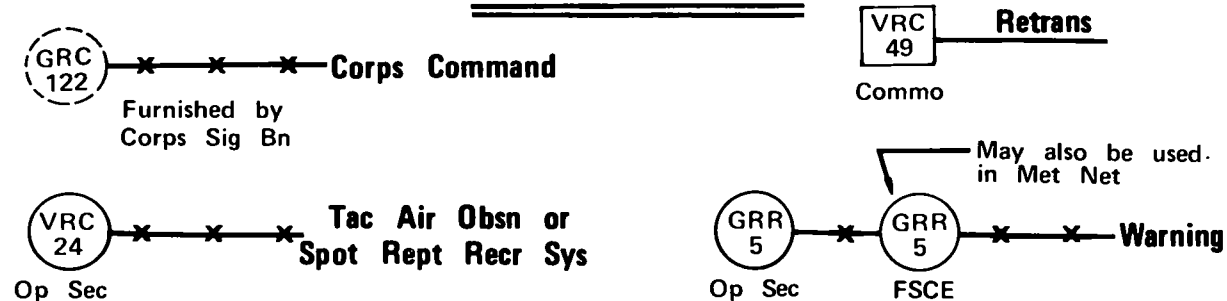


Figure 130. Radio nets, HHB, corps artillery, TOE 6-501G.



EXTERNAL NETS



FOR DISPLACEMENT

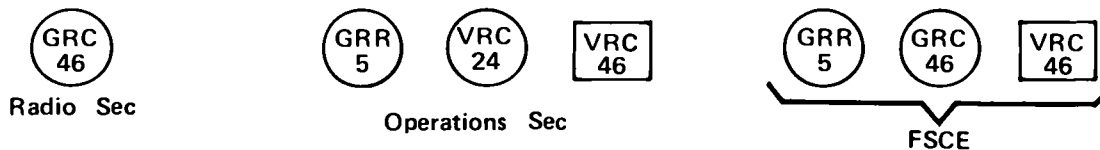
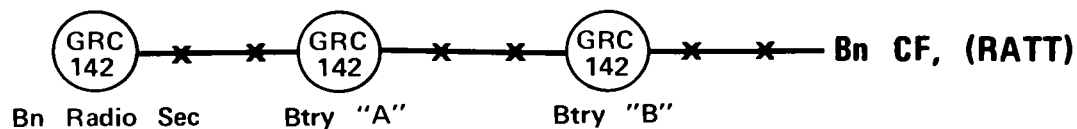
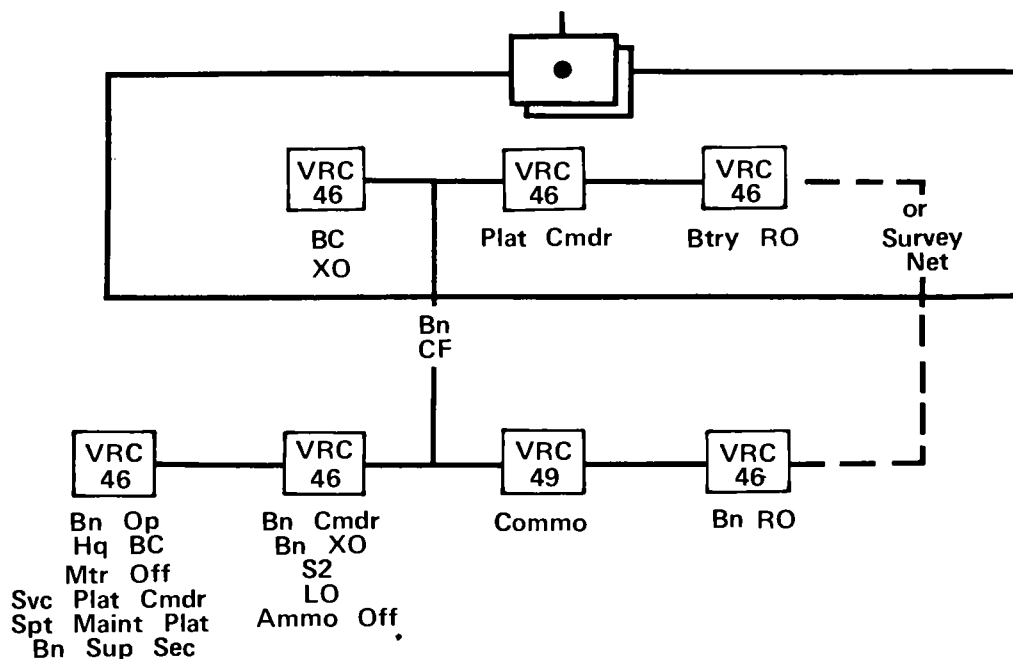


Figure 132. Radio nets, HHB, airborne corps artillery, TOE 6-502G.

- 3 GRR-5
- 3 GRC-125
- 8 PRC-25
- 21 VRC-46
- 1 VRC-49
- 5 GRC-142



EXTERNAL NETS

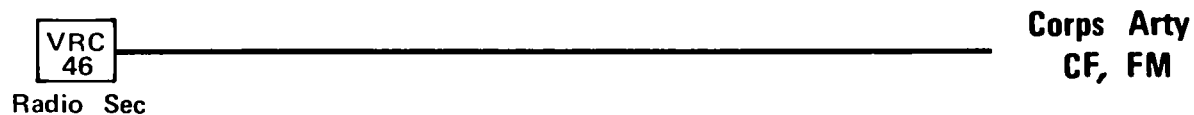
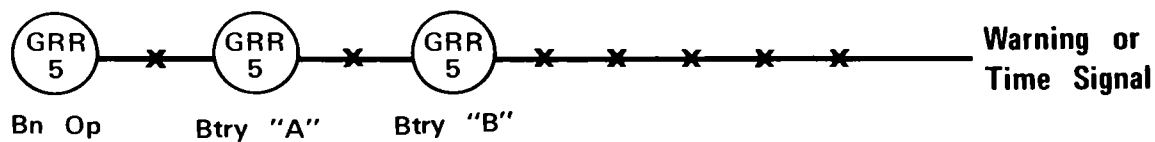
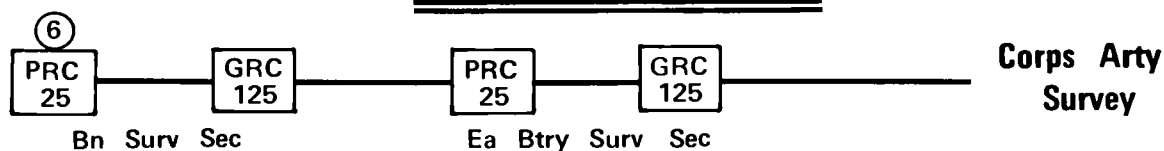


Figure 134. Radio nets, Sergeant battalion, TOE 6-555G.

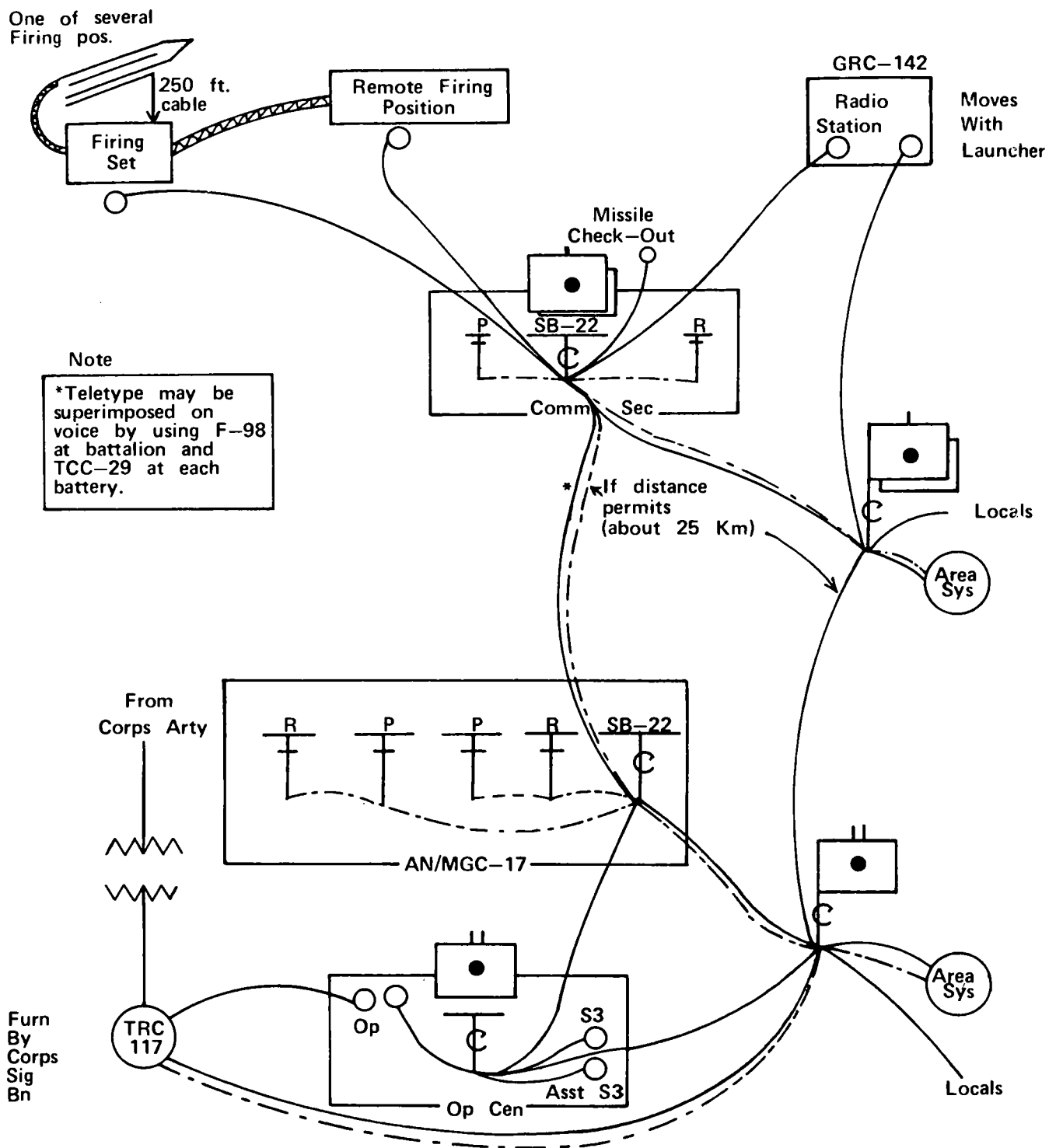
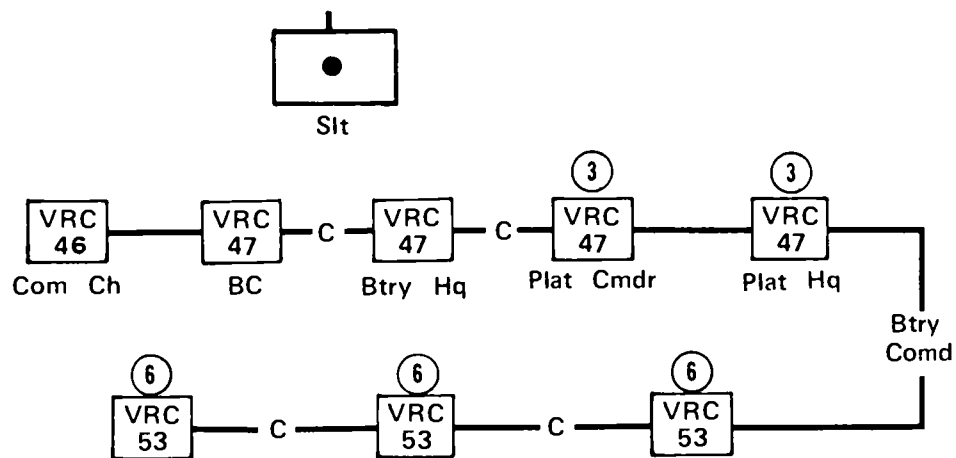


Figure 135. Wire system, Sergeant battalion, TOE 6-555G.

4 GRR-5
1 VRC-46
8 VRC-47
18 VRC-53



Three Platoons of six
Searchlight sections each

EXTERNAL NETS

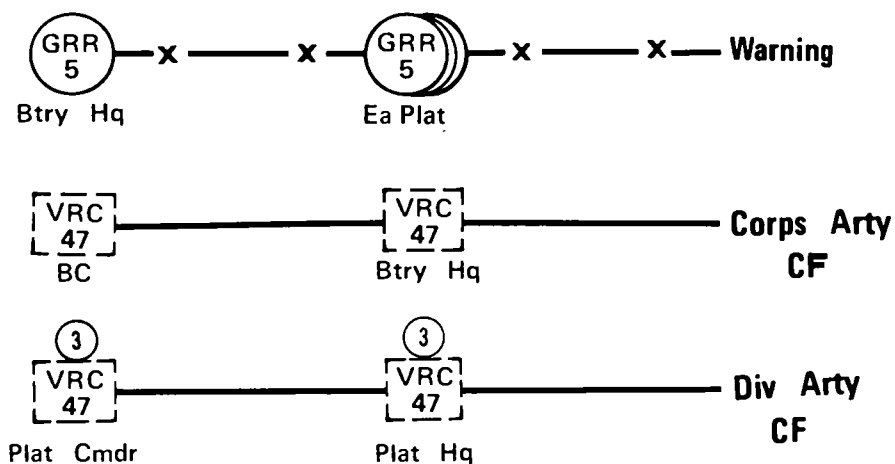
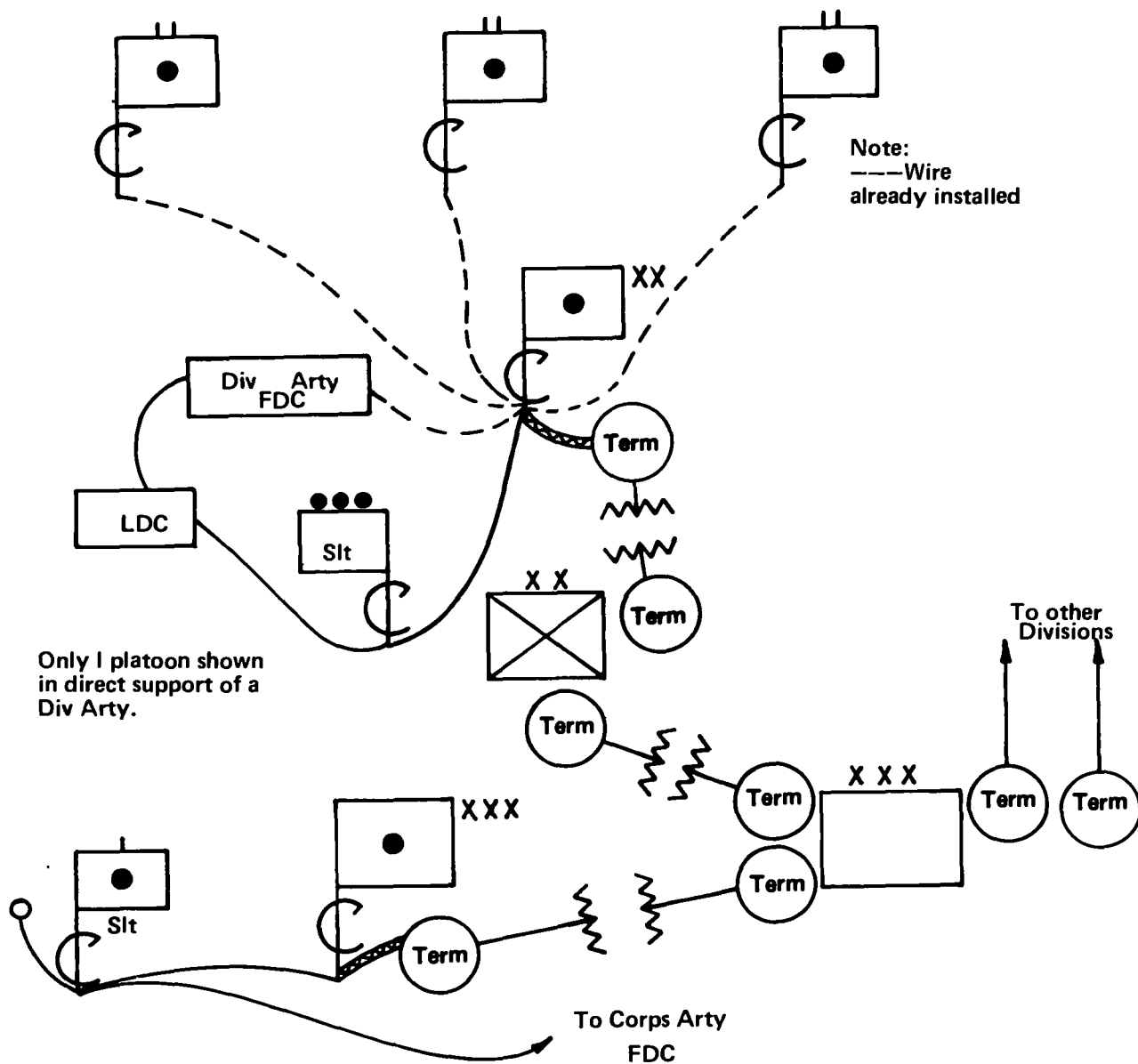


Figure 136. Radio nets, searchlight battery, TOE 6-558G.



AGO 7808A

Other two batteries operate with their respective division artilleries or FA groups.

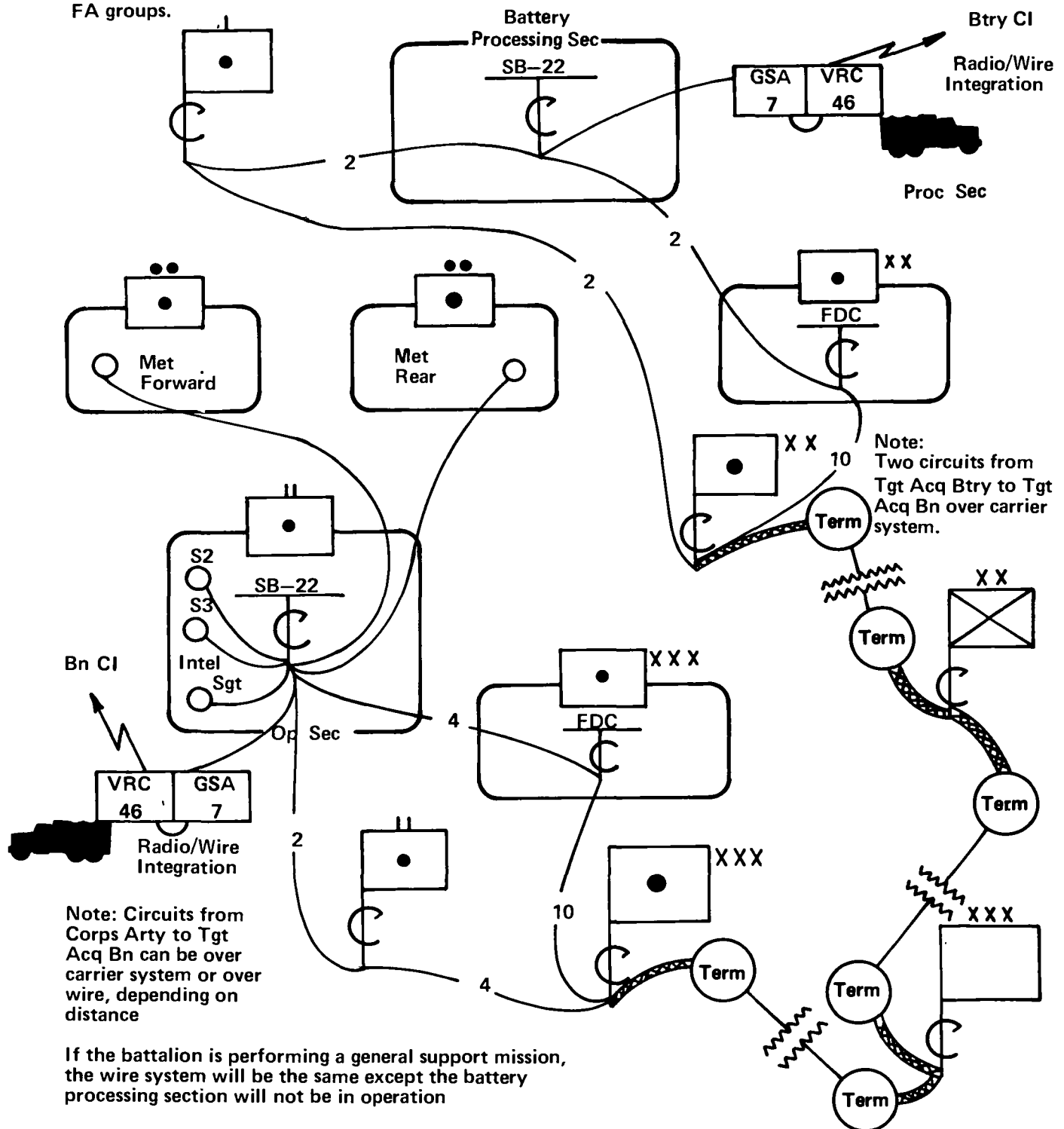


Figure 138. Wire system, target acquisition battalion, TOE 6-575G.

Type Radio	Bn Hq	Ea of 3 Batteries	Total Bn
GRR- 5	2	1	5
GRC- 125	6	15	51
VRC- 46	9	15	54
VRC- 47	3	4	15
VRC- 49	1	1	4
GRC- 142	4	2	10

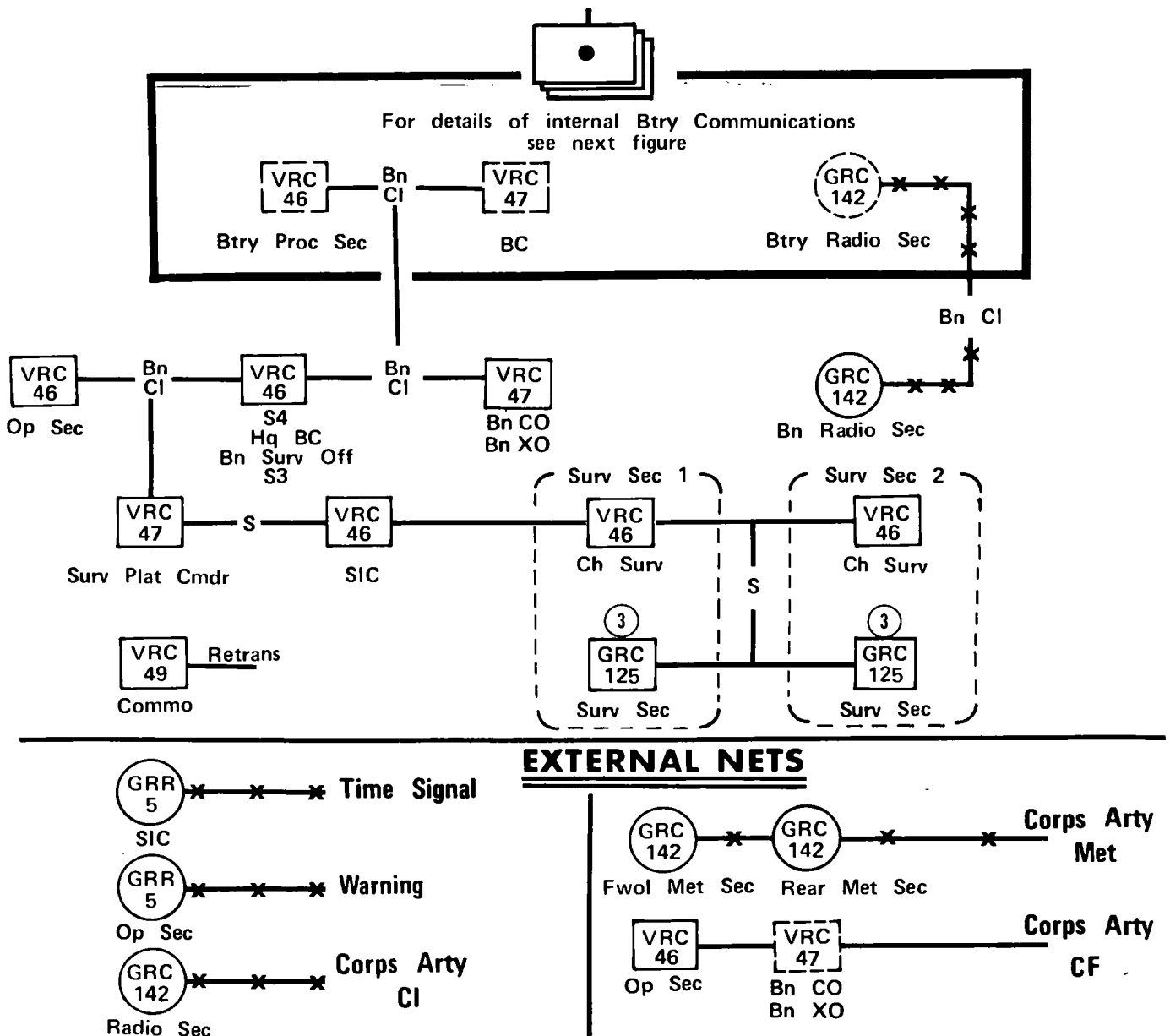
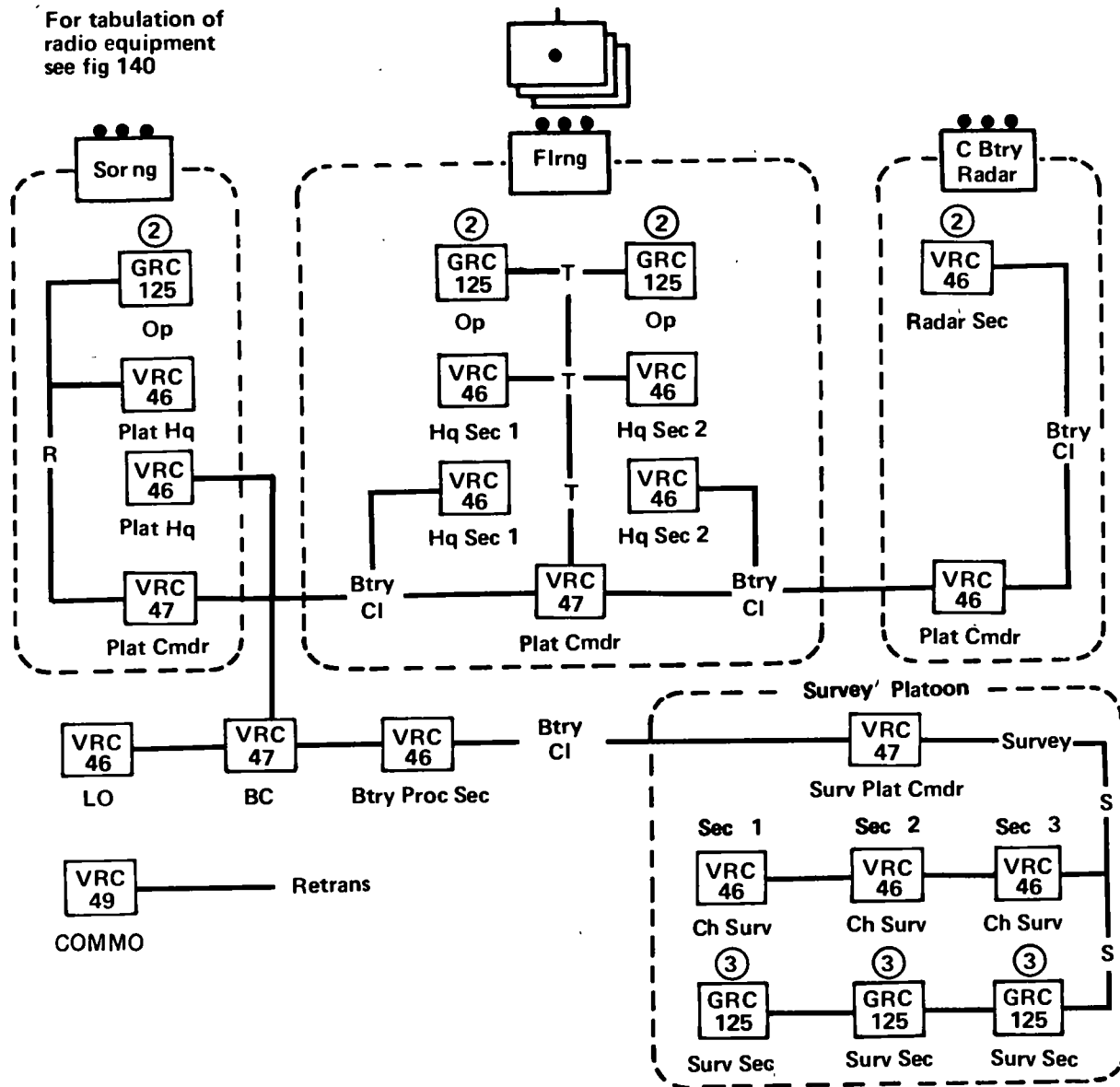


Figure 139. Radio nets, HHB, target acquisition battalion, TOE 6-576G.

For tabulation of
radio equipment
see fig 140



EXTERNAL NETS

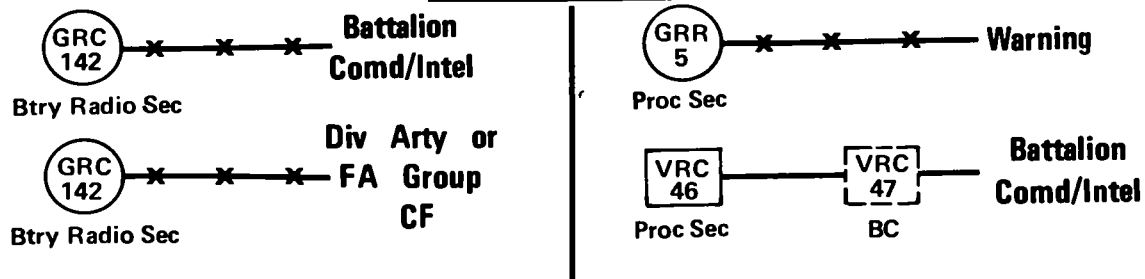


Figure 140. Radio nets, target acquisition battery, TOE 6-577G.

***Note**

If battalion performs a general support mission, the battery processing section is not used, lines shown will be routed to the btry Comd Swbd instead.

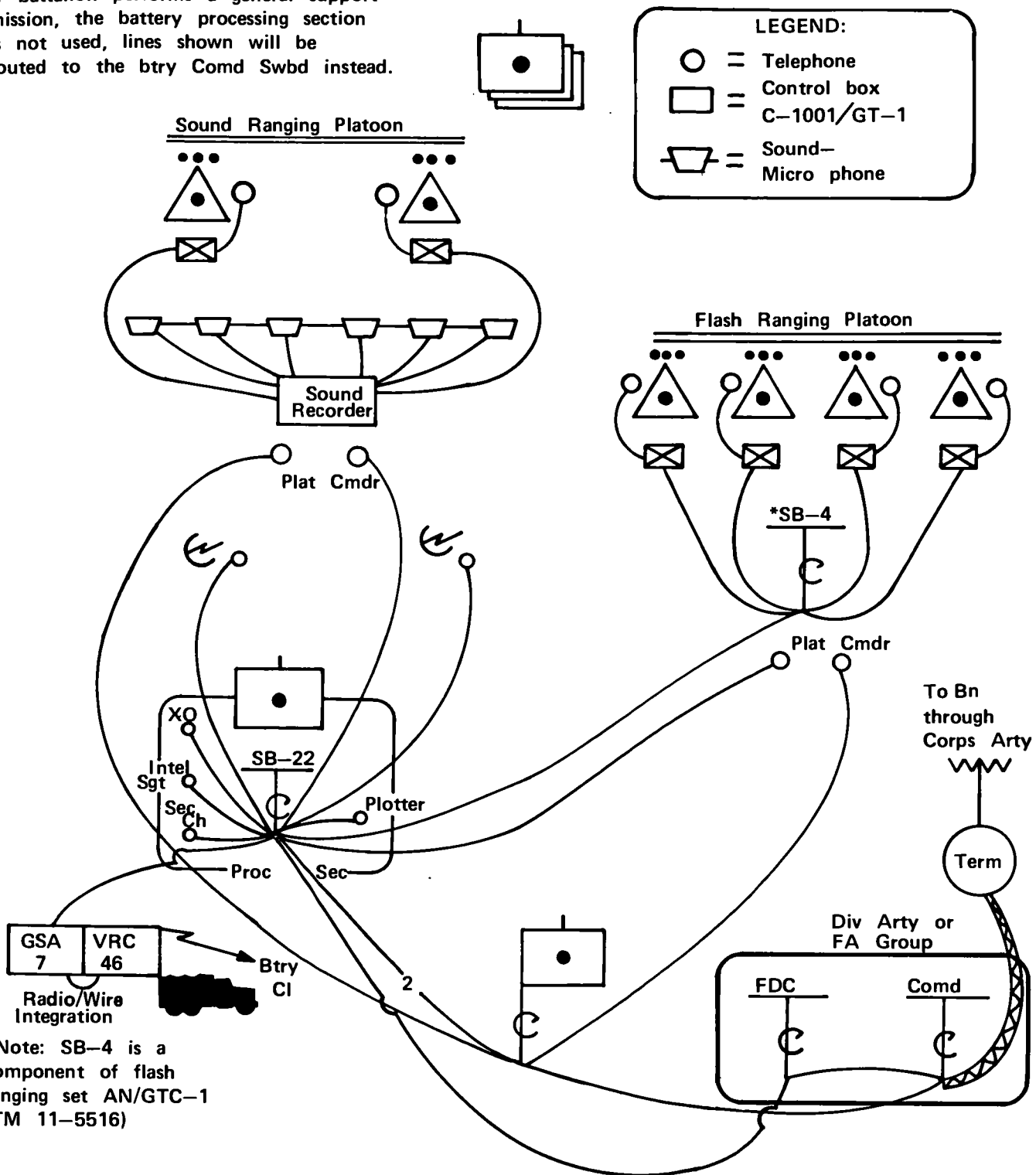


Figure 141. Wire system, target acquisition battery, TOE 6-577G.

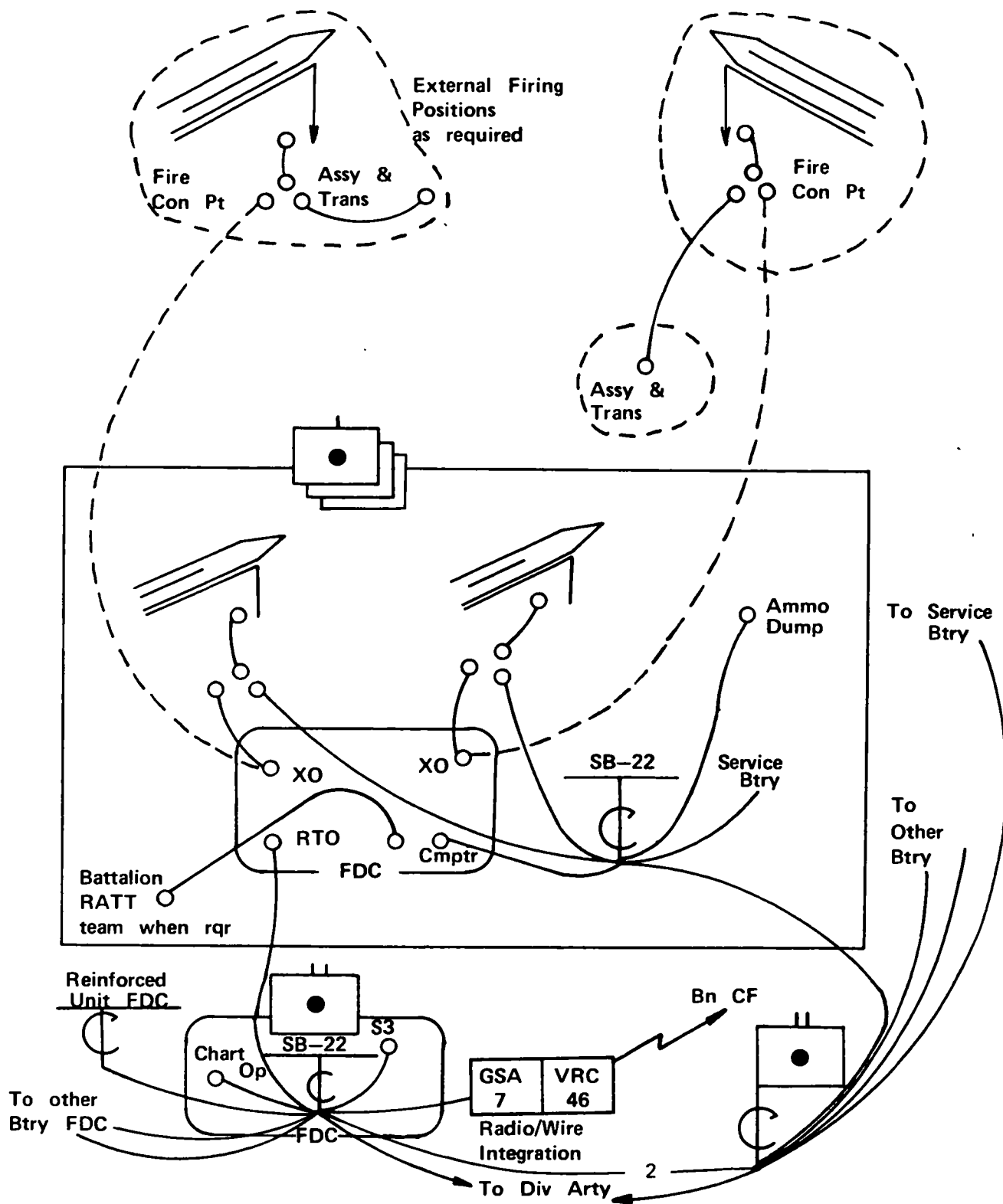


Figure 143. Wire system, Lance battalion, TOE 6-595T.

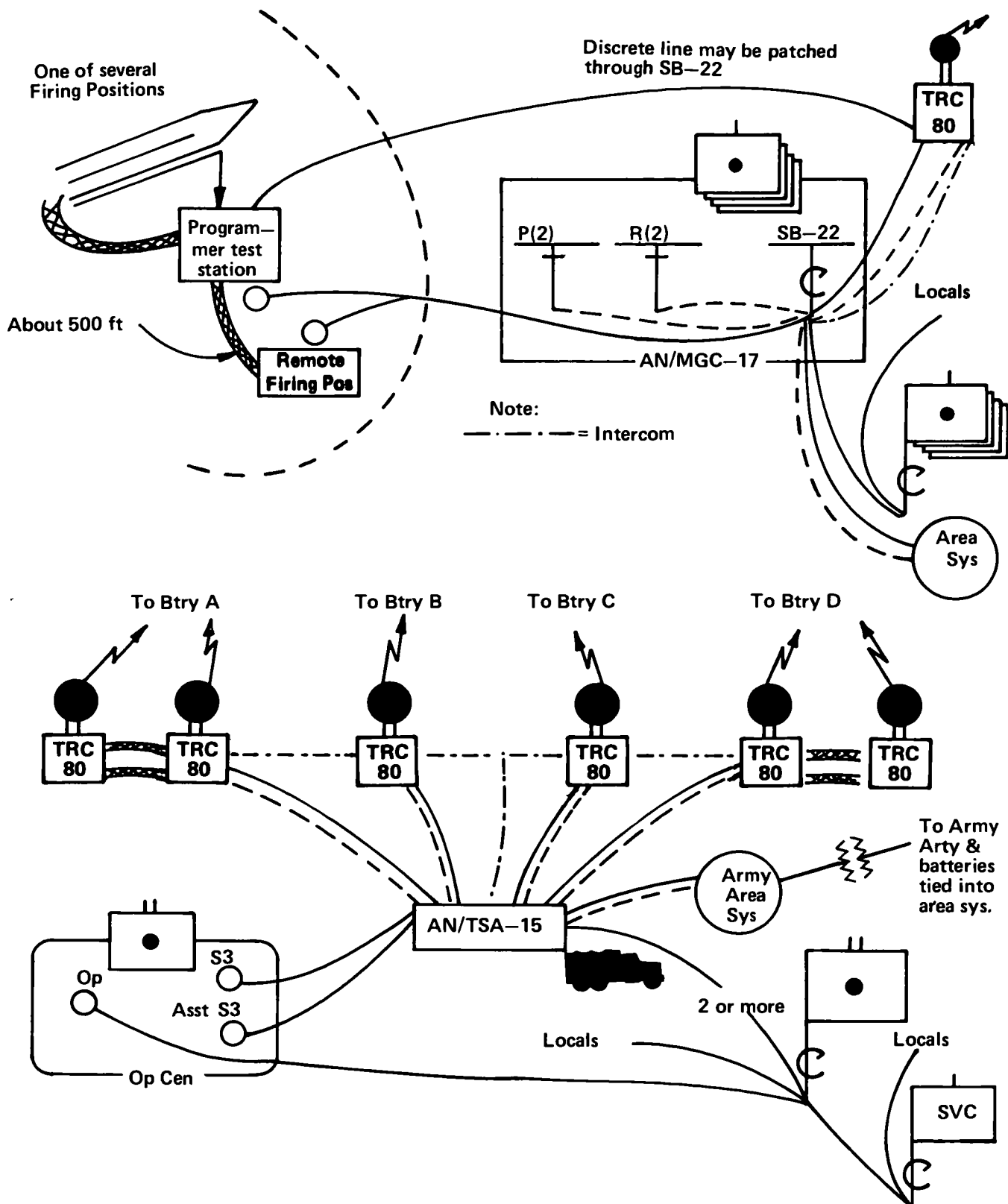
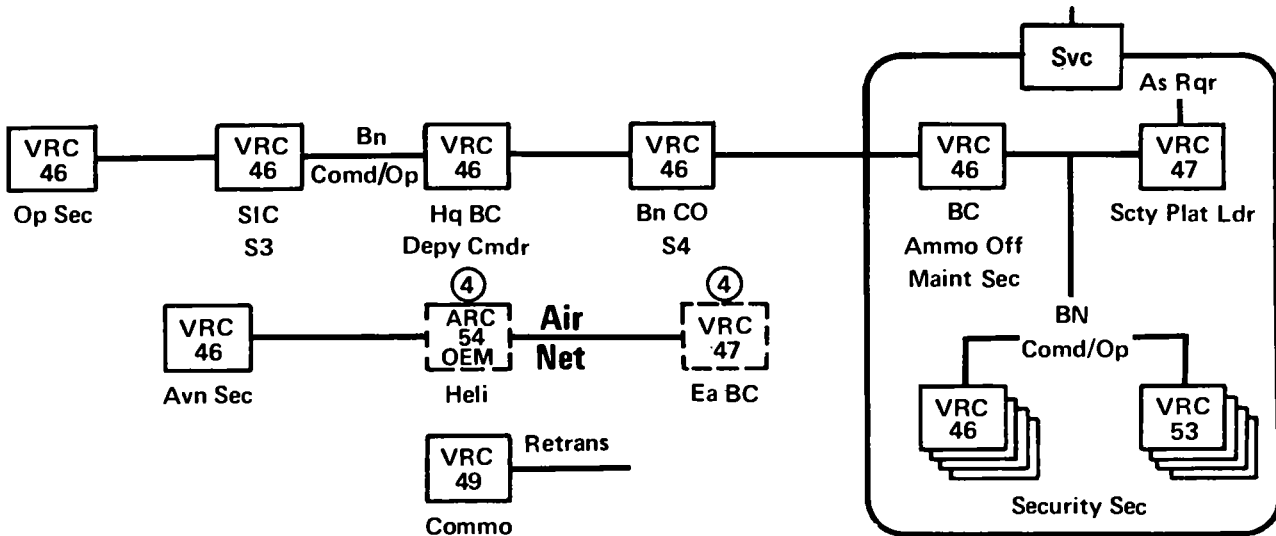
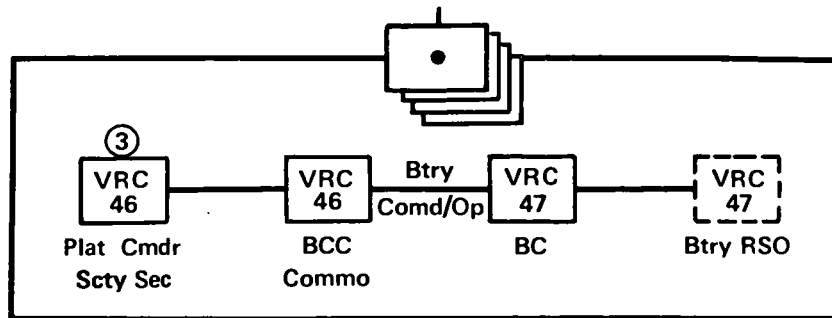


Figure 145. Troposcatter radio, wire, and teletype systems, Pershing battalion, TOE 6-615D.

19 GRR-5
16 PRC-25
1 GRC-106
1 VRC-24
47 VRC-46
9 VRC-47
1 VRC-49
4 VRC-53
13 TRC-133
10 TRC-80



EXTERNAL NETS

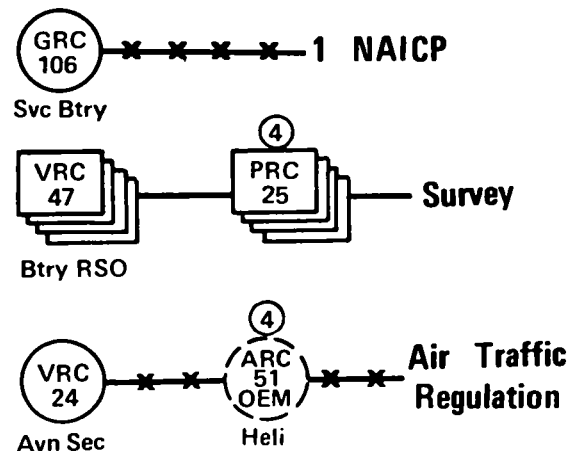
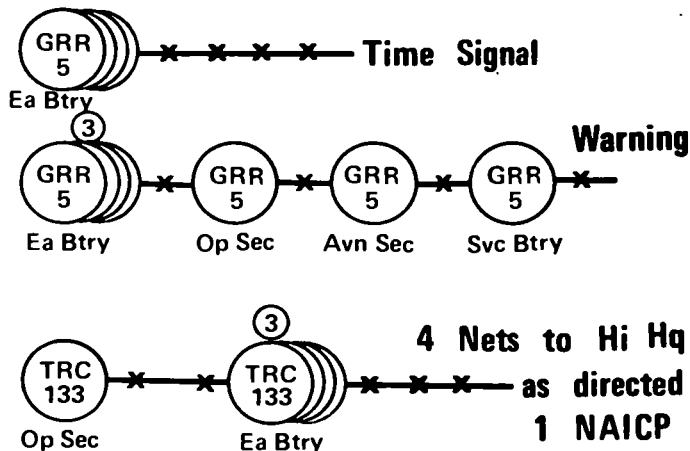
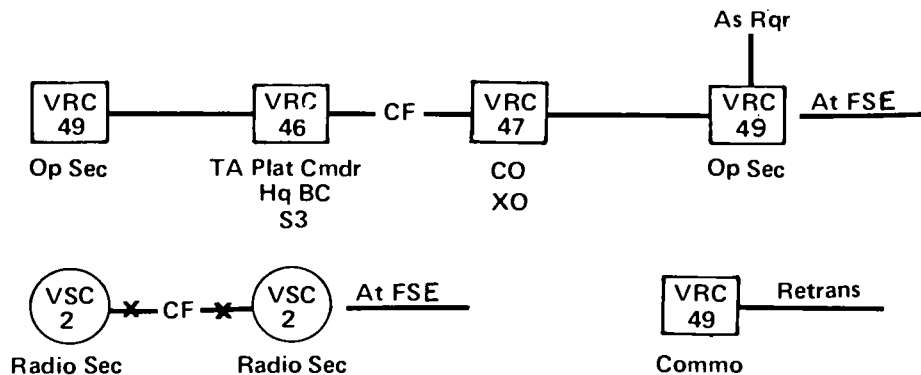


Figure 146. Radio nets, Pershing battalion, TOE 6-615G.

1	GRR 5
3	GRC 125
3	PRC 25
1	PRC 47
1	VRC 24
3	VRC 46
2	VRC 47
4	VRC 49
3	VSC 2



EXTERNAL NETS

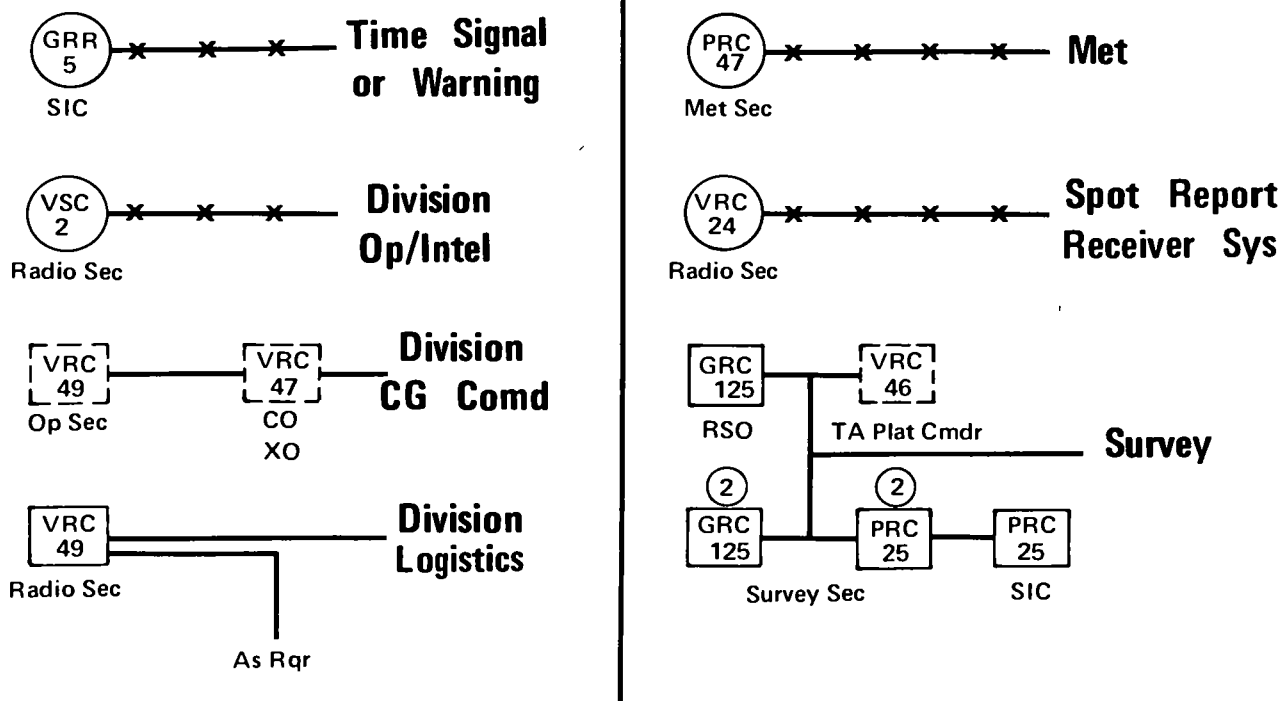


Figure 148. Radio nets, HHB, airmobile division artillery, TOE 6-701T.

2 PRC- 25
1 VRC- 24
3 VRC- 46
2 VRC- 47
1 VSC- 2
1 ASC- 5

1 Airborne Command Post, (used as rqr)

Control Central AN/ASC-5
Consisting of: 1 AN/ARC-102
1AN/VRC-24
3 AN/VRC-46
6 Panel Controls C- 1611
5 Headsets H-101

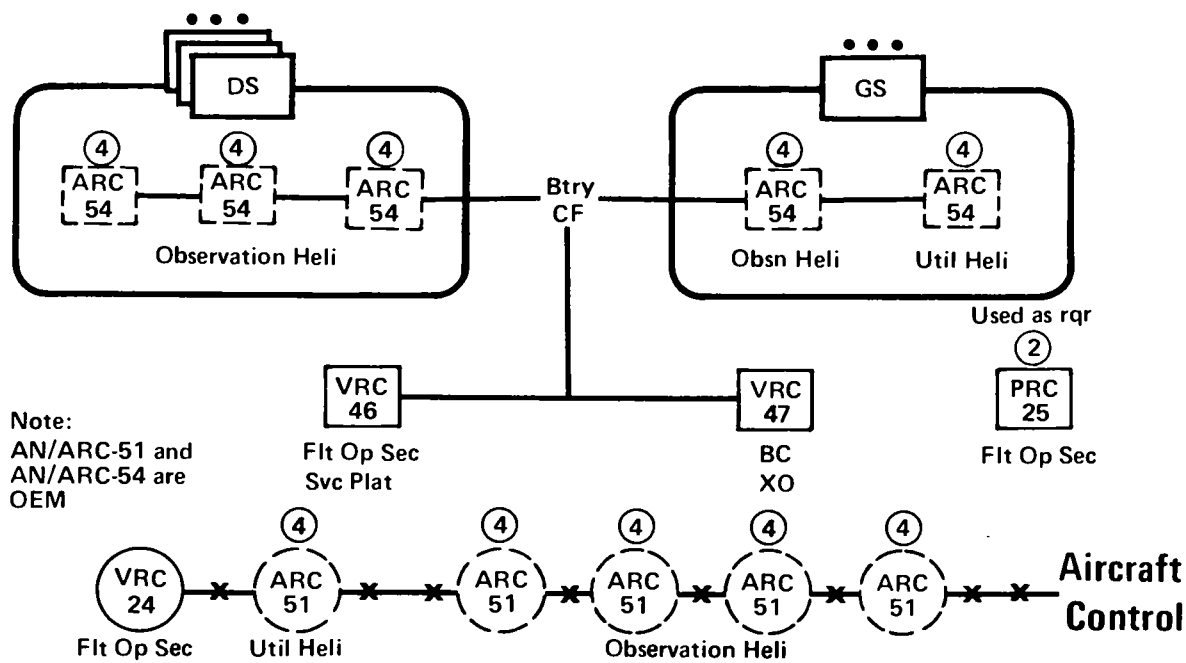
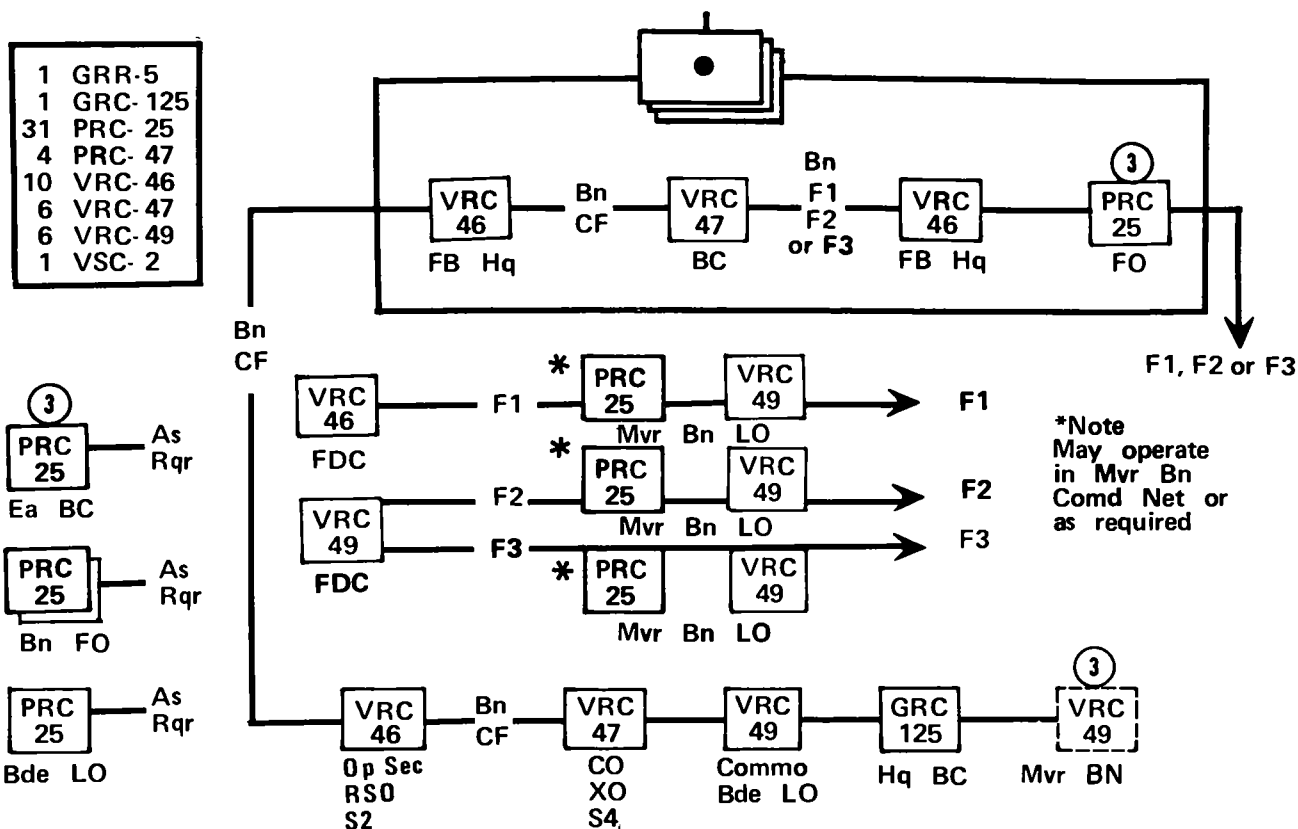


Figure 149. Radio nets, aviation battery, airmobile division artillery, TOE 6-702T.



EXTERNAL NETS

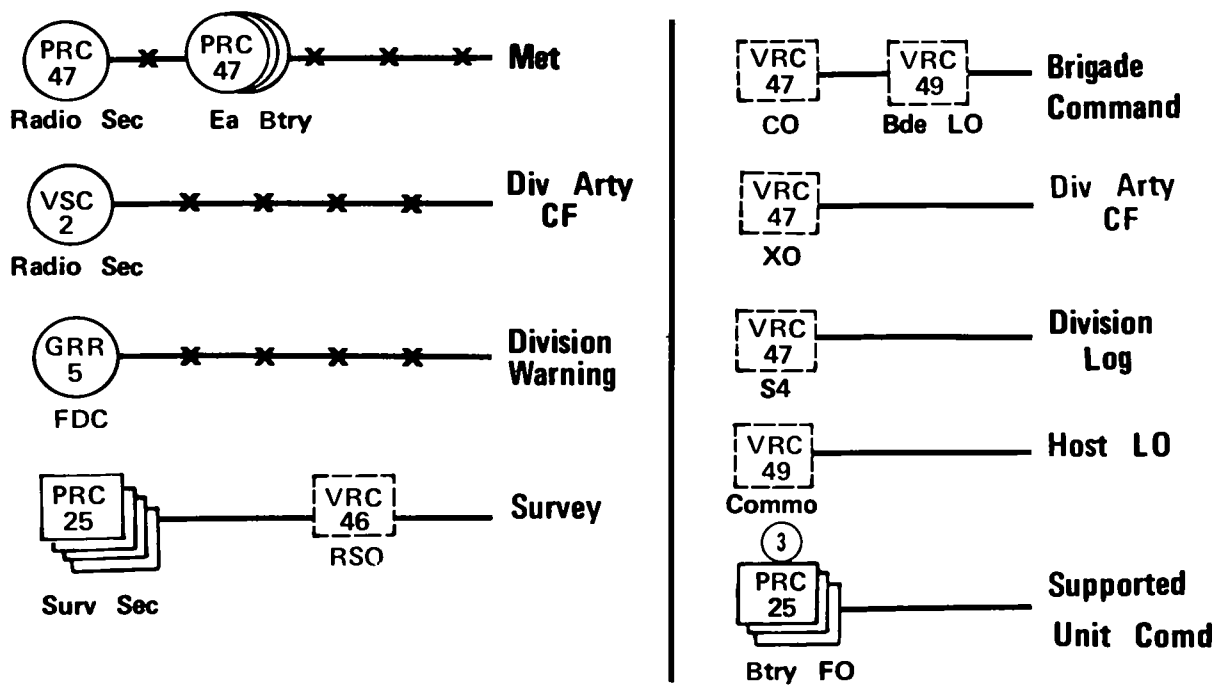


Figure 150. Radio nets, 105-mm battalion, airmobile division artillery, TOE 6-705T.

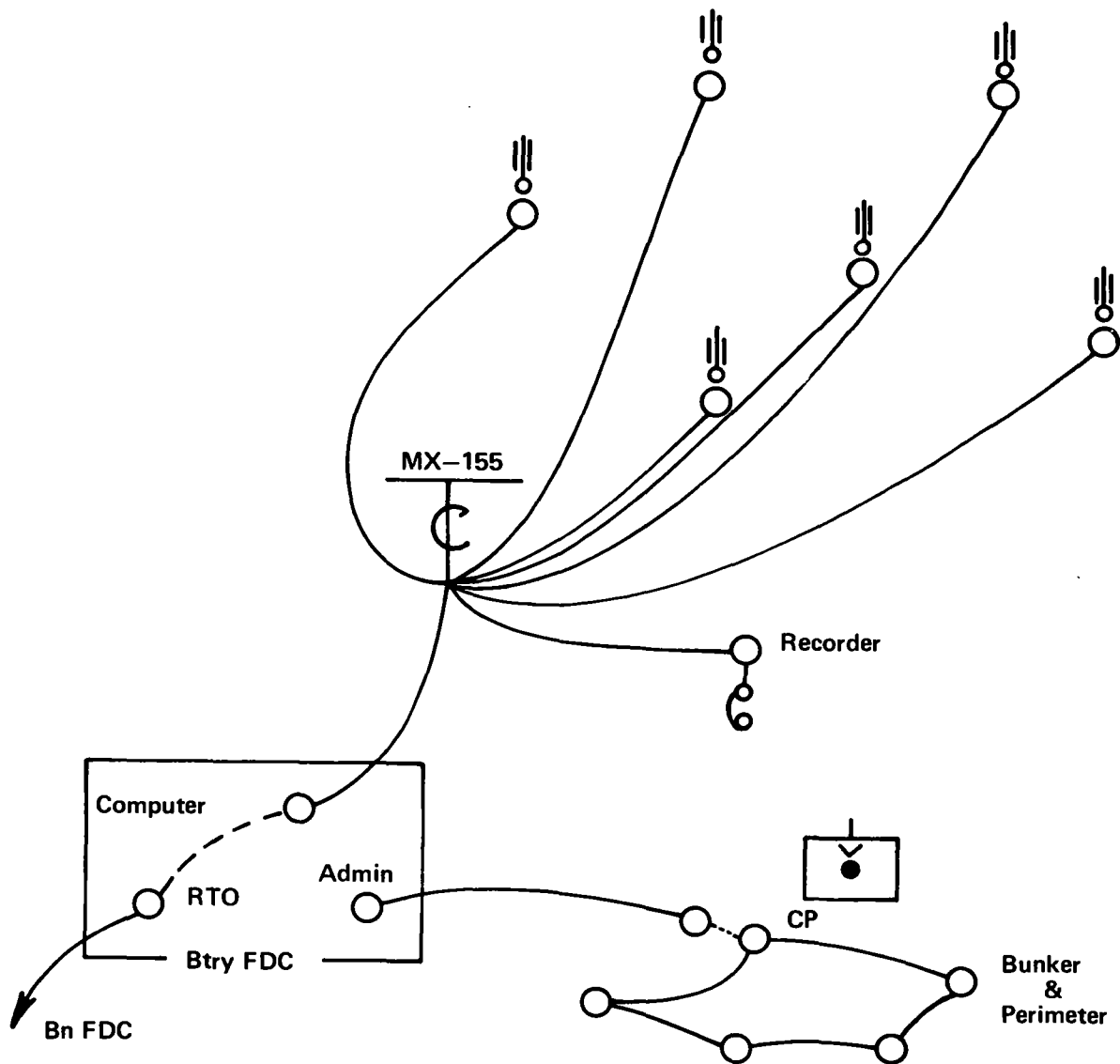
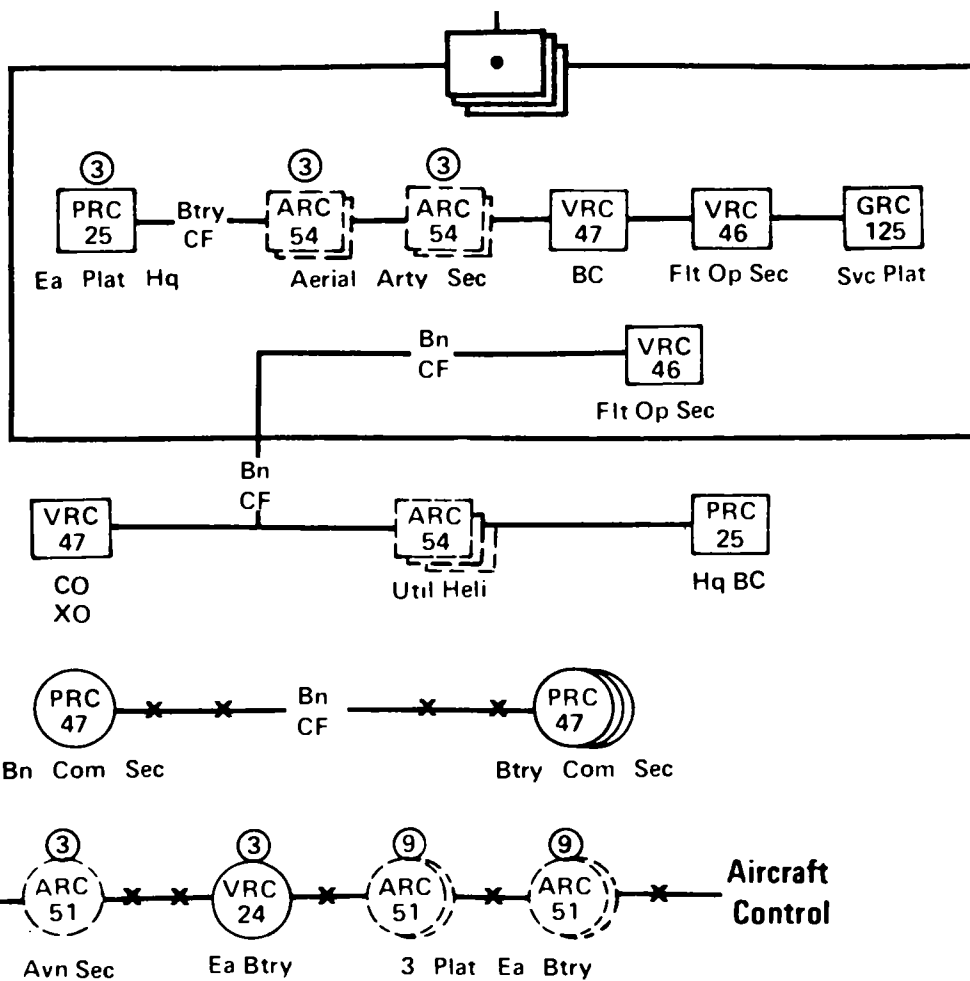


Figure 151. Wire system, 105-mm battery airmobile division artillery, TOE 6-707T.

- 3 GRC-125
- 10 PRC-25
- 4 PRC-47
- 4 VRC-24
- 6 VRC-46
- 5 VRC-47
- 2 VRC-49
- 1 VSC-2



EXTERNAL NETS

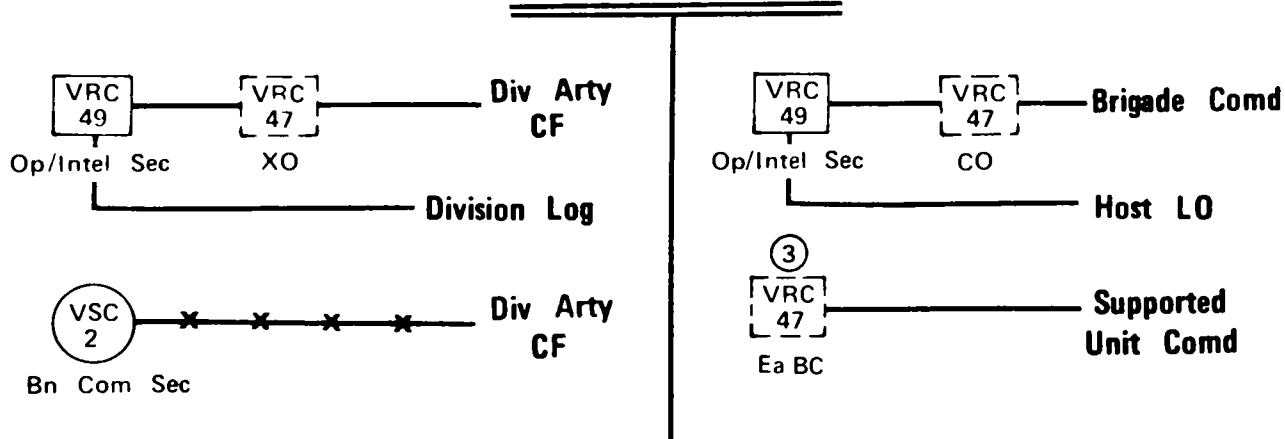


Figure 152. Radio nets, aerial artillery battalion, airmobile division artillery, TOE 6-725T.

APPENDIX A

REFERENCES

1. Allied Communication Publications (ACP)

(CMH) ACP-121 ()	Communication Instructions, General (U).
(CMH) ACP-122 ()	Communication Instructions, Security (U).
(CMH) ACP-124 ()	Communication Instructions Radiotelegraph Procedures (U).
ACP-125 ()	Communication Instructions Radiotelegraph Procedure.
ACP-125 () US Supp2	Radio Telephone Procedure for the Conduct of Artillery and Naval Gunfire.
(CMH) ACP-126 ()	Communication Instructions Teletypewriter Procedure (U).
ACP-134 ()	Telephone Switchboard Operating Procedure.

2. Department of Defense Publications

National Security Agency (S-Crypto) KAG-1()/TSEC	Cryptographic Operations (U).
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3. Army Regulations (AR)

105-31	Message Preparation and Processing.
310-25	Dictionary of U.S. Army Terms.
310-50	Authorized Abbreviations and Brevity Codes.
345-210	Records Management—File Systems and Standards
380-5	Safeguarding Defense Information.
380-6	Security, Automatic, Time-phased, Downgrading and Declassification System.
380-26	Policy for Use of Encrypt-For-Transmission Only (EFTO) Procedure.
(C) 380-40	Department of the Army Policy for Safeguarding COMSEC Information (U).
380-41	Control of COMSEC Material.
(S) 380-46	Control of Compromising Emanations (U).
(C) 380-52	Codes, Nonmachine Ciphers and Authentication Systems (U).
604-5	Clearance of Personnel for Access to Classified Defense Information and Material.
725-50	Requisitioning, Receipt and Issue System.
735-35	Supply Procedures for TOE and TDA Units or Activities.
750-5	Organization, Policies, and Responsibilities for Maintenance Operations.

4. Joint Army, Navy, Air Force Publications

(C) JANAP 201() Status of Noncryptographic JANAP's and ACP's (U).

5. DA Pamphlets (Indexes for Military Publications) (DA Pam)

108-1	Index of Army Motion Pictures and Related Audio-Visual Aids.
310-1	Index of Administrative Publications, Regulations, Circulars, Pamphlets, Posters, Joint Chiefs of Staff Publications, and General Orders).
310-3	Index of Doctrinal, Training, and Organizational Publications (Field Manuals, Reserve Officers' Training Corps Manuals, Training Circulars, Army Training Programs, Army Subject Schedules, Army Training Test, Firing Tables and Trajectory Charts, Tables of Organization and Equipment, Type Tables of Distribution and Tables of Allowances.
310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals, (Types 7, 8, and 9) Supply Bulletins, and Lubrication Orders.
310-6	Index of Supply Catalogs and Supply Manuals (Excluding types 7, 8, and 9).
310-7	U.S. Army Equipment Index of Modification Work Orders.
(C) 310-9	Index of Communications Security (COMSEC) Publications (U).

6. DA Supply Bulletins (SB)

11-131	Vehicular Radio Sets and Authorized Installations.
11-602	Oscillator 0-574/GRA (5820-082-4049) for Use with Certain Applications of AN/GSA-7.
700-20	Adopted Items of Materiel and Army Reportable Items.

7. Field Manuals (FM)

6-3 series	Gun Direction Computer M18.
6-20-1	Field Artillery Tactics.
6-20-2	Field Artillery Techniques.
6-40	Field Artillery Cannon Gunnery.
11-50	Signal Battalion, Armored, Infantry and Infantry (Mechanized) Divisions.
11-57	Signal Battalion, Airborne Division.
11-92	Corps Signal Battalion and Airborne Corps Signal Battalion.
21-5	Military Training Management.
21-6	Techniques of Military Instruction.
21-60	Visual Signals.
22-100	Military Leadership.
24-1	Tactical Communications Doctrine.

24-16	Signal Orders, Records and Reports.
24-17	Tactical Communications Center Operations.
24-18	Field Radio Techniques.
24-19	Communications-Electronics Reference Data.
24-20	Field Wire and Field Cable Techniques.
(C) 32-5	Signal Security (SIGSEC) (U).
(S) 32-15	Broadcast Countermeasures (U).
(C) 32-20	Electronic Warfare (Ground Based) (U).
(S) 32-20A	Electronic Warfare (Ground Based) (U).
61-24	Division Communications.
101-5	Staff Officers' Field Manual Staff Organization and Procedure.

8. Technical Manuals (TM)

5-2805-203-14	Organizational, DS, and GS Maintenance Manual: Engine Gasoline Models 4A032-1 and 4A032-11.
5-6115-271-15	Organizational, DS, GS and Depot Maintenance Manual: Generator Set Gasoline Engine, 3KW, AC, 400 Cycle (Less Engine).
9-1220-221-10	Operator's Manual Computer, Gun Direction M18.
9-1220-221-20/1	Organizational Maintenance Manual: Computer, Gun Direction M18.
9-1220-221-20/2	Organizational Maintenance Manual: Computer, Gun Direction M18.
9-1220-221-20P	Organizational Maintenance Repair Parts and Special Tool Lists for Computer Gun Direction M18.
9-1290-326-12	Organizational Maintenance Manual: Reproducer, Signal Data, AN/GSQ-64.
9-1290-326-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Reproducer, Signal Data, AN/GSQ-64.
9-4931-204-12/1	Operator and Organizational Maintenance Manual: Test Set, Computer Logic Unit AN/GSM-70.
9-4931-204-12/2	Operator and Organizational Maintenance Manual: Test Set, Computer Logic Unit AN/GSM-70.
9-4931-204-20P	Organizational Maintenance Repair Parts and Special Tool Lists for Test Set, Computer Logic Unit AN/GSM-70.
11-286	Radio Sets AN/VRC-8, AN/VRC-9, and AN/VRC-10.
11-287	Radio Sets AN/VRQ-1, AN/VRQ-2, and AN/VRQ-3.
11-381	Cable Assembly CX-1065/G, Telephone Cable Assemblies CX-1606/G and CX-1512/U, Telephone Loading Coil Assembly CU-260/G, Electrical Connector Plugs U-176/G and U-226/G and Maintenance Kit, Cable Splicing MK-640/G.
11-486-6	Electrical Communications System Engineering: Radio.

11-611	Radio Sets AN/VRC-16, AN/VRC-17 and AN/VRC-18.
11-678	Fundamentals of Telephony.
11-2059	Telephone TP-9 and Telephone TA-264/PT.
11-2134	Manual Telephone Switchboard SB-86/P: Installation and Operation.
11-2240	Wire Dispenser, MX-306A/G.
11-3895-207-10	Operator's Manual: Reeling Machines, Cable, Motor Driven RL-172/G and RL-172A/G.
11-3895-209-12	Operator's and Organizational Maintenance Manual: Reeling Machine, Cable, Engine Driven, RL-207/G.
11-5038	Control Group AN/GRA-6.
11-5805-201-12	Organizational Maintenance Manual: Telephone Set, TA-312/PT.
11-5805-243-12	Operation and Organizational Maintenance, Telephone Set TA-1/PT.
11-5805-254-15	Operator's, Organizational, Field and Depot Maintenance Manual: Terminal Telegraph-Telephone AN/TCC-14.
11-5805-262-12	Operator's and Organizational Manual: Switchboards Telephone Manual SB-22/PT and SB-22A/PT.
11-5805-303-20P	Organizational Maintenance Repair Parts and Special Tools List Connecting and Switching Kit MX-155/GT.
11-5805-356-12	Organizational Maintenance Manual: Terminal, Telegraph-Telephone, AN/TCC-29.
11-5815-200-12	Organizational Maintenance Manual: Including Repair Parts and Special Tool Lists Teletypewriter Set AN/UGC-4.
11-5815-204 series	Radioteletypewriter Sets AN/GRC-46, -46A, -46B and AN/VRC-29.
11-5815-206-12	Operator's and Organizational Maintenance Manual: Teletypewriter Sets, AN/PGC-1, TT-4()/TG, TT-335/TG and TT-537/TG.
11-5815-238-12	Organizational Maintenance Manual: Teletypewriter Sets AN/GGC-3() and Teletypewriter Reperforator-Transmitter TT-76()/GGC.
11-5815-334-12	Operator and Organizational Maintenance Manual: Radioteletypewriter Sets AN/GRC-142 and AN/GRC-122.
11-5820-222 series	Radio Set AN/VRC-24.
11-5820-284-15	Organizational Maintenance Manual: Radio Receiving Set AN/GRR-5.
11-5820-292 series	Radio Sets AN/PRC-8, -8A, -9, -9A, -10, -10A.
11-5820-295 series	Radio Set AN/GRC-19.
11-5820-398 series	Radio Set AN/PRC-25.
11-5820-401 series	Radio Sets AN/VRC-12 and AN/VRC-43, -44, -45, -46, -47, -48 and -49.
11-5820-477-12	Organizational Maintenance Manual: Radio Set Control Groups AN/GRA-39 and AN/GRA-39A.

11-5820-520-12	Operator and Organizational Maintenance Manual: Radio Set AN/GRC-106.
11-5820-549-12	Operator and Organizational Maintenance Manual: Receiving Set, Radio AN/PRR-9, Transmitting Set, Radio AN/PRT-4, and Indicator Channel Alignment ID-1189/PR
11-5820-590-12-1	Organizational Maintenance Manual: Radio Set AN/PRC-74B.
11-5820-667-12	Operator and Organizational Maintenance Manual: Radio Set AN/PRC-77.
11-6625-496-12	Organizational Maintenance Manual: Test Set, Radio AN/VRM-1.
11-6625-514-12	Organizational Maintenance Manual: Test Set, Electronic Circuit Plug-in Unit AN/GRM-55.
38-750	Army Equipment Record Procedures.

APPENDIX B

SYMBOLS

1. Short Titles for Radio Nets

The short titles shown in figure 154 are used in conjunction with artillery radio net diagrams and the discussions of radio nets. Frequency modulated (FM) nets are shown by a solid line, amplitude modulated (AM) nets are shown by a solid line on which a series of X's are superimposed at convenient intervals. Suffix numbers are added to the short titles if more than one net is used for the same purpose; i.e., F1, F2, F3 if a unit has three fire direction nets.

2. Basic Communication Symbols

The basic communication symbols are shown in figure 155.

3. Metric Notations

Terra	10^{12}	-----	1,000,000,000,000
Giga	10^9	-----	1,000,000,000
Mega	10^6	-----	1,000,000
Kilo	10^3	-----	1,000
Hecto	10^2	-----	100
Deca	10^1	-----	10
Unit	10^0	-----	1
Deci	10^{-1}	-----	0.1
Centi	10^{-2}	-----	0.01
Milli	10^{-3}	-----	0.001
Micro	10^{-6}	-----	0.000,001
Nano	10^{-9}	-----	0.000,000,001
Peco	10^{-12}	-----	0.000,000,000,001

FM Nets	Purpose	AM Nets
—— CF ——	Command Fire Direction	— x — CF — x —
—— F ——	Fire Direction	— x — F — x —
—— CI ——	Command Intelligence	— x — CI — x —
—— CL ——	Command Light Direction	
—— R ——	Sound Ranging	
—— T ——	Flash Ranging	
—— S ——	Survey	
	Meteorological	— x — M — x —
—— LN ——	Liaison	— x — LN — x —
—— CO ——	Command Operations	— x — CO — x —
- - - - -	Alternate Net (or net of secondary interest)	- x - - - - x -

Figure 154. Short titles for radio nets.

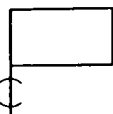
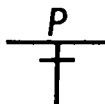
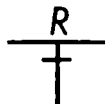
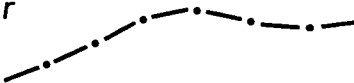
Repeating coil (Simplex coil) on a line circuit		Not always provided	
Wire circuit with telephone set TA-312/ PT		Telephone switching central at a command post or headquarters	
Remote control unit for radio		Radar station	
Wire circuit, indicating number of pairs available		Telephone switching central at a command post or headquarters	
Telephone		Teletype facilities	
Teletypewriter Page Printer		Teletypewriter Reperforator	
Multi-channel cable		Signal center, operated by signal unit	
FM Radio		AM Radio	
Teletypewriter circuit		Forward Observer (Artillery)	
		Searchlight	

Figure 155. Communication symbols.

APPENDIX C

TABULATION AND DESCRIPTION OF COMMUNICATIONS-ELECTRONICS EQUIPMENT

Table 2. Old FM Radios

Radio set	Receiver/transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total	Channels Preset	Power requirement	Reference manual	Remarks
AN/GRC-3	R-108/RT-66/RT-70	20.0-27.9	Voice	16-24	80	2	12/24 VDC	TM 11-284	3 preset channels on aux receiver; set utilizes AM-65 AF amplifier.
-5	R-109/RT-67/RT-70	27.0-38.9			120	2			
-7	R-110/RT-68/RT-70	38.0-54.9			170	2			
AN/GRC-4	RT-66/RT-70	20.0-27.9	Voice	16-24	80	2	12/24 VDC	TM 11-284	Set utilizes AM-65 AF amplifier.
-6	RT-67/RT-70	27.0-38.9			120	2			
-8	RT-68/RT-70	38.0-54.9			170	2			
AN/VRC-8	RT-66	20.0-27.9	Voice	16-24	80	2	12/24 VDC PP-109/GR(12V) PP-112/GR(24V)	TM 11-286	
-9	RT-67	27.0-38.9			120	2			
-10	RT-68	38.0-54.9			170	2			
AN/VRC-13	RT-66	20.0-27.9	Voice	16-24	80	2	12/24 VDC	TM 11-291	Set utilizes AM-65 AF amplifier.
-14	RT-67	27.0-38.9			120	2			
-15	RT-68	38.0-54.9			170	2			
AN/VRC-16	R-108/RT-66	20.0-27.9	Voice	16-24	80	2	12/24 VDC PP-448(6 volt) PP-281(12 volt) PP-282(24 volt)	TM 11-611	3 preset channels on aux receiver.
-17	R-109/RT-67	27.0-38.9			120	2			
-18	R-110/RT-68	38.0-54.9			170	2			
AN/VRC-20	R-108/RT-66	20.0-27.9	Voice	16-24	80	2	12/24 VDC	TM 11-642	3 preset channels on aux receiver; set utilizes AM-65 AF amplifier.
-21	R-109/RT-67	27.0-38.9			120	2			
-22	R-110/RT-68	38.0-54.9			170	2			
AN/VRQ-1	2 RT-66	20.0-27.9	Voice	16-24	80	2	12/24 VDC	TM 11-287	Provides automatic re-transmission capability. Can also be used for duplex operation.
-2	2 RT-67	27.0-38.9			120	2			
-3	2 RT-68	38.0-54.9			170	2			

AN/VRC-7	RT-70	47.0-58.4	Voice	1.6	115	2	6/12/24 VDC & 6 V PP-448/GR	TM 11-285	Set utilizes AM-65 AF amplifier.
AN/PRC-6	RT-196/PRC-6	47.0-55.4	Voice	1.6	43	1	BA-270	TM 11-296	Can use long-life BA-4270/U FSN 6135-390-0031
AN/PRC-8	RT-174/PRC-8	20.0-27.9	Voice	5-8	80	Continuous tuning.	BA-279/U or 24 VDC w/AM-598/ U	TM 11-4065	AM-598/U is an amplifier, power supply. (BA- 2279/U for arctic oper- ation).
-9	RT-175/PRC-9	27.0-38.9			120				
-10	RT-176/PRC-10	38.0-54.9			170				

Table 3. New FM Radios

Radio set	Receiver/ transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total	Channels Preset	Power requirement	Reference manual	Remarks
AN/PRC-25	RT-505/PRC-25	30.00-52.95 53.00-75.95	Voice	8	920	2	Dry btry BA-386/U mag btry BA-4386 FSN 6135-926- 8322.	TM 11-5820-398-12	Replaces AN/PRC-8, -9, and -10 for manpack only.
AN/PRC-77	RT-841/PRC-77	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	8	920	2	BA-386/PRC-25 or BA-398/U.	TM 11-5820-667-12	X-mode for security device BA-398/U is for arctic operation.
AN/PRC-79	RT-841/PRC-77 +AM-4306/ PRC	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	24-32	920	2	BA-386/PRC-25 or BA-398/U.	TM 11-5820-667-12	Amplified version of AN/ PRC-77, AM-4306 is RF amplifier, using its own battery of same type.
AN/PRC-80	RT-505/PRC-25 +AM-4306/ PRC.	30.00-52.95 53.00-75.95	Voice	24-32	920	2	Dry Btry BA- 386/U.	TM 11-5820-398-12	Amplified version of AN/ PRC-25. AM-4306 is RF amplifier.
AN/VRC-53	RT-505/PRC-25	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	8	920	2	24 VDC vehicular battery.	TM 11-5820-398-12	Vehicular configuration of AN/PRC-25.
AN/VRC-64	RT-841/PRC-77	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	8	920	2	24 VDC vehicular battery.	TM 11-5820-667-12 and C 1 of TM 11-5820-498-12.	Vehicular configuration of AN/PRC-77.

Table 3. New FM Radios—Continued

Radio set	Receiver/transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total	Channels Preset	Power requirement	Reference manual	Remarks
AN/VRC-65	RT-841/PRC-77 +AM-4306/ PRC.	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	24-32	920	2	24 VDC vehicular battery.	TM 11-5820-667-12 and C 1 of TM 11-5820-498-12.	Vehicular configuration of AN/PRC-79.
AN/VRC-66	RT-505/PRC-25 +AM-4306/ PRC.	30.00-52.95 53.00-75.95	Voice	24-32	920	2	24 VDC vehicular battery.	TM 11-5820-498-12	Amplified version of AN/VRC-53. AM-4306 is RF amplifier.
AN/GRC-125	RT-505/PRC-25	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	8	920	2	Dry btry or vehicular battery.	TM 11-5820-498-10	On/off vehicular configuration of AN/PRC-25.
AN/GRC-160	RT-841/PRC-77	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	8	920	2	Dry btry or vehicular battery.	TM 11-5820-667-12 and C 1 of TM 11-5820-498-12.	On/off vehicular configuration of AN/PRC-77.
AN/GRC-161	RT-841/PRC-77 +AM-4306/ PRC.	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	24-32	920	2	Dry btry or vehicular battery.	TM 11-5820-667-12 and C 1 of TM 11-5820-498-12.	On/off vehicular configuration of AN/PRC-79.
AN/GRC-162	RT-505/PRC-25 +AM-4306/ PRC.	30.00-52.95 53.00-75.95	Voice	24-32	920	2	Dry btry or vehicular battery.	TM 11-5820-498-10	Amplified version of AN/GRC-125, AM-4306 is RF amplifier.
AN/GRC-163	1 AN/VRC-47 *1 AN/TCC-70	30.00-52.95 53.00-75.95	Voice & 150-Hz tone.	15-50 Using 2 antennas Log periodic for long range.	920	2	PP-2953B/U 110-220 VAC, 60- to 400-Hz, to 24 VDC & gasoline engine generator 1.5-kw, 120 V.	TM 11-5820-713-15	This terminal set provides voice and teletype communication by using the multiplexer AN/TCC-70. For point-to-point communication. Requires two frequencies per link.
AN/VRC-12	RT-246/VRC R-442/VRC	30.00-75.95	Voice	24-32	920	10	24 VDC	TM 11-5820-401-10	Replaces AN/VRC-16, -17, and -18.
AN/VRC-43	RT-246/VRC	30.00-75.95	Voice	24-32	920	10	24 VDC	TM 11-5820-401-10	Replaces AN/VRC-8, -9, and -10.
AN/VRC-44	RT-246/VRC 2 R-442/VRC	30.00-75.95	Voice	24-32	920	10	24 VDC	TM 11-5820-401-10	No previous configuration having this capability.
AN/VRC-45	2 RT-246/VRC	30.00-75.95	Voice	24-32	920	10	24 VDC	TM 11-5820-401-10	Replaces AN/VRQ-1, -2, and -3.

AN/VRC-46	RT-524/VRC	30.00-75.95	Voice	24-32	920	0	24 VDC	TM 11-5820-401-10	Replaces AN/VRC-8, -9, and -10.
AN/VRC-47	RT-524/VRC R-442/VRC	30.00-75.95	Voice	24-32	920	0	24 VDC	TM 11-5820-401-10	Replaces AN/VRC-16, -17, and -18.
AN/VRC-48	RT-524/VRC 2 R-442/VRC	30.00-75.95	Voice	24-32	920	0	24 VDC	TM 11-5820-401-10	No previous configuration having this capability.
AN/VRC-49	2 RT-524/VRC	30.00-75.95	Voice	24-32	920	0	24 VDC	TM 11-5820-401-10	Replaces AN/VRQ-1, -2, and -3.
AN/PRC-88 Squad Radio.	AN/PRT-4 transmitter.	47.00-57.00	Voice & tone.	1.6 .5	200	2	BA-399/U	TM 11-5820-549-12	Compatible with AN/VRC-12 and AN/PRC-25 series. Channel alignment indicator ID-1189/PR is required since radio is crystal controlled. Has 50-kHz spacing.
	AN/PRR-9 receiver.	47.00-57.00		Provided with earphone H-264/ PRR-9.	200 usable channels depend on crystals made available.	1	BA-505/U or BA-4505/U (Magnesium).		
AN/GRT-13 radio transmitting set (site marking device).	AN/GRT-13 development item.	45.0-54.8	Tone-modulated omni-directional signal (on 6 sec, off 4 sec).	NA	50	50 (one at a time).	BA-386/PRC (15 volt).	TM 11-5820-608-12 (when published).	Used in conjunction with organic FM equipment to form a homing system for the purpose of locating airdropped supply bundles. Radio set AN/PRC-10 or AN/PRC-25 equipped with homing loop antenna AT-784/PRC is used.

*Multiplexer Set AN/TCC-70 is a lightweight tactical equipment. It provides four telephone traffic channels for voice or data, one order wire channel, and two telegraph channels. It operates with another distant multiplexer over a four-wire cable or a radio circuit, using radio receiver R-442/VRC and radio receiver-transmitter RT-246/VRC or RT-524/VRC. The telegraph channels are compatible with telegraph terminals TH-5/TG and TH-22/TG. Remarks: TM 11-5805-413-12; TM 11-5805-413-34; Traffic capacity—4 telephone channels: 2 simultaneous full-duplex or half-duplex telegraph channels plus order wire with provision for 2 additional telegraph channels on a plug-in basis.

Table 4. AM Radios

Radio set	Receiver/transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total	Channels Preset	Power requirement	Reference manual	Remarks
AN/PRC-47	RT-671/PRC-47	2 to 11.999 in 1-kHz increments	CW & upper sideband voice & FSK	Planning range 80 km	10,000		BB-451/U or vehicular battery	TM 11-5820-509-12	Used in airmobile operations. Portable by rucksack (requiring 2 men) using battery power, or vehicular mounting, using vehicular battery. In fixed station operation can use 115 volts single phase, 400 Hz. Uses antenna AS-1320/PRC-47 (15-ft whip) & AS-1321 (long-wire).
AN/GRC-19	R-392/URR T-195/GRC-19	0.5-32.0 1.5-20.0	Voice CW	80	Manual	7 XMTR	28.0 VDC 44 amps	TM 11-5820-295-10	Part of AN/GRC-46, AN/VRC-29, and AN/VSC-1. Being replaced by AN/GRC-106.
AN/GRC-46	R-392/URR T-195/GRC-19	0.5-32.0 1.5-20.0	Voice CW, FSK simultaneous voice & FSK	80	Manual	7 XMTR	28.0 VDC 100 amps	TM 11-5815-204-10	Mounted in shelter S-89 or S-144. Standard B item, being replaced by AN/GRC-142. Has on-line security capability.
AN/GRC-26 (A, B, & C)	2 R-388/URR 1 BC-610 (A, B, C)	0.5-30.5 2.0-18.0	Voice CW, FSK simultaneous voice & FSK	160 voice 400 CW & FSK	Continuous manual control		115 VAC 50-60 Hz 5 kw approx	TM 11-5820-202-10 & TM 11-5820-256-10	Has full duplex capability. Provides on-line secure communication. Extended ranges with doublet antenna.
D	2 R-390/URR 1 T-368/URT	0.5-32.0 1.5-20.0	simultaneous voice & FSK						
AN/GRR-5	R-174/URR (receiver only)	1.5-18.0	Voice CW MCW	NA		10	6/12/24 VDC, w/PP-308, 115 VAC	TM 11-295 & TM 11-5820-284-series	Can operate with dry cells (2 BA-419 and 1 BA-403).
AN/URC-4	RT-159/URC-4	120.0-130.0 & 240.0-260.0	Voice MCW tone	16/32/64 w/aircraft at 1,000, 5,000, & 10,000 ft	2 fixed	1	BA-1264/U	TM 11-510	Emergency aviator's radio for rescue situations, dropped in survival kit or carried on person in a vest.

AN/URC-10	RT-278/URC-10	238.0-263.0	Voice & tone	56 line of sight	1 fixed		16 V dry btry BA-1387/URC-10	TM 11-5820-640-15	Replaces AN/URC-4 personnel rescue radio set.
AN/VRC-24	RT-323/VRC-24	225.0-399.9	Voice	48 at 1,000 ft; 160 at 10,000 ft	1750	19	24 VDC	TM 11-5820-222-series	Ground-to-air communication. Compatible with AN/ARC-27, AN/ARC-55 or AN/ARC-51. Can retransmit from PRC-9 to VRC-14 and from AM-65 to VRC-24.
AN/VRC-29									AN/GRC-46 less shelter. Configuration for mounting in tanks and APC's.
AN/VRC-34	RT-77/GRC-9	2.0-12.0	Voice CW MCW	Voice 16-24 CW 24-48	Continuous or 6 crystal freq		6/12 VDC w/DY-88/GRC-9 24 VDC w/DY-105/GRC-9	TM 11-263	Vehicular version of AN/GRC-9. AN/GRC-87 when not mounted. Uses DC gen GN-43 or GN-58, & battery BA-317/U.
AN/VSC-1	R-392/URR T-195/GRC-19	0.5-32.0 1.5-20.0	Voice CW FSK	80		7 XMTR	27.5 VDC 100 amps	TM 11-5815-204-series	AN/GRC-46 air-droppable version (mounted in 1/4 ton), less shelter, reperforator-teletype, and on-line security equipment.
AN/PRC-41 (UHF receiver-transmitter)	RT-695/PRC-41	225.0-399.9	Voice (AM)	48 at 1,000 ft, 160 at 10,000 ft, also depending on antenna	1750 crystal control (100-kHz channel spacing)		BB-451/U; PP-3700/PRC-41 (fixed station) or vehicular btry	TM 11-5820-510-12	Can operate from 115-230 volts, 50 to 400 Hz. Permits manpack, fixed station, or vehicular operation. Uses either directional antenna AS-1405/PRC-41 or omnidirectional antenna AS-1404/PRC-41. Used for ground-to-air communication, such as forward air controller. On TOE of airmobile division.

Table 5. Single Sideband Radios

Radio set	Receiver/transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total Channels Preset	Power requirement	Reference manual	Remarks
AN/GRC-106	*RT-662/GRC	2.0-29.999	Voice CW	80	28,000	28 VDC veh btry or PP-4763/GRC	TM 11-5820-520-series & TM 11-5820-765-12	Replacement for AN/GRC-19. May be mounted on ¼-ton vehicle.
AN/GRC-142	*RT-662/GRC & Modem MD-522A	2.0-29.999	Voice, CW, FSK, voice & FSK simul-taneously	80 ground-wave, 2,400 skywave	28,000	28 VDC 100-amp high capacity gen or 10 kw gen	TM 11-5820-520-series, TM 11-5805-387-15-1 & -2, TM 11-5815-334-12	Replacement for AN/GRC-46. On-line security capability. Half duplex operation. Shelter mounted (S-318) ¾-ton. Can use PP-4763/GRC (28 VDC at 50 amps from 115 VAC).
AN/GRC-122	*2 RT-662/GRC & Modem MD-522A	2.0-29.999	Same as AN/GRC-142	80 ground-wave, 2,400 skywave	28,000	28 VDC 100 amp high capacity generator or 10-kw generator	TM 11-5820-520-series, TM 11-5805-387-15-1 & -2; & TM 11-5815-334-12	Same as AN/GRC-142, except for additional RT-662 and auxiliary equipment for full duplex operation. Can use PP-4763/GRC (28 VDC at 50 amps from 115 VAC).
AN/GRC-108	2 RT-662/GRC w RF amplifier AM-3399 & modem MD-522A	2.0-29.999	Same as AN/GRC-142	160 ground-wave, 2,400 skywave	28,000	115-230 V trailer-mounted 10-kw gen	None published	Replacement for AN/GRC-26 shelter mtd. Full duplex with on-line security. Initially mounted on 2½-ton truck, but will ultimately be mounted on ¾-ton truck.
AN/VSC-2	RT-662/GRC & modem MD-522A	2.0-29.999	Same as AN/GRC-142	80 ground-wave, 2,400 skywave	28,000	**27.5 VDC 28 to 115 V inverter SS-688 to provide AC for TT operation	TM 11-5808-387-15-1 & -2, TM 11-5815-331-14	Replacement for AN/VSC-1. Same as AN/GRC-142 less reperforator. Mtd in ¼-ton veh for airborne operations.
AN/VSC-3	RT-662/GRC & modem MD-522A	2.0-29.999	Same as AN/GRC-142	80 ground-wave, 2,400 skywave	28,000	28 VDC high capacity veh generator	TM 11-5815-332-15 (when published) TM 11-5805-387-15-1 & -2	Replacement for AN/VRC-29. Mounted in M577 vehicle.

AN/FRC-93 (KWM-2A) (Collins)***	RT-778/FRC-93	3.4-29.999	Voice & CW	80 ground- wave	Contin- uous tuning	115 VAC single phase 60 hertz & PP-3990/FRC-93	TM 11-5820-529-15 (Also Collins instruction book)	Used in Pershing battalion. Also found in airmobile units commercial off- the-shelf item for SSB communication.
AN/PRC-74B	RT-794/PRC-74	2.0-17.999	Voice & CW	40 ground- wave	Vernier con- trolled detent tuning in 1 kHz steps	70 BA-30 or 2 BA- 386 or PP-4514/ PRC-74 is 110/ 220-volt power is available	TM 11-5820-590- 12-1	Half-duplex capability. Can use 12 volt nickel- cadmium wet cell battery.
AN/TRC-133	5 KWM-2A radio sets (RT-778/ FRC-93)	3.4-29.999	Voice & CW	80 ground- wave	Contin- uous tuning	Two 5-kw generators with PP-3990/ FRC-93	No TM. See POMM 11-5820-610-15	5 AN/FRC-93 radio sets mounted in shelter S-141 and trailer w/2 5-kw generators. 1 radio set only is capable of mobile communication while traveling. Uses power supply PP-4151/FRC- 93 in conjunction with vehicular electrical system.
AN/MRC-95	RT-698/ARC-102 (Collins type) (618T-3)	2.0-29.999	Voice CW FSK	80 ground- wave	28,000	Vehicular power 28-volt generator system + power converter 770B-1	TM 11-5820-514-12	Mounted in ¼-ton vehicle. Can provide ground-to- air communication with aircraft using radio set AN/ARC-102 or other sets in the 2.0-29.9 MHz frequency range. Used in airmobile units as an interim item until the AN/VSC-2 becomes available.

Notes.

*PP-4763 is used when commercial power is utilized (TM 11-5820-765-12)

**Uses PU-675 for fixed or semifixed operation (3 kw, 28-volt DC gen + battery) mounted in ¼-ton trailer M146; requires 25-ft cable between PU-675 and VSC-2.

***The AN=TRC-133 (Pershing Bn) contains 5 of these sets.

Table 6. Army Aircraft Radios

Radio set	Receiver/ transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total Channels Preset	Power requirement	Reference manual	Remarks
AN/ARC-44	RT-294/ARC-44	24.0-51.9	FM Voice CW for homing.	Line of sight (see note).	280 preset	27.5 VDC	TM 11-5821-204- series.	Air-to-ground communica- tion. Compatible with old series of FM radios. 100-kHz channel spacing. Replaced by AN/ARC- 54 or AN/ARC-131.

Table 6. Army Aircraft Radios—Continued

Radio set	Receiver/transmitter	Frequency (MHz)	Operation modes	Range (KM)	Total Channels Preset	Power requirement	Reference manual	Remarks
AN/ARC-45	RT-295/ARC	225.0-399.9	VHF/UHF AM voice.	(see note)	1750 12 preset	27.5 VDC	TM 11-5821-299-series.	Air-to-air & air-to-ground communication. Replaces AN/ARC-60.
AN/ARC-51	RT-650/ARC-51	225.0-399.9	VHF/UHF AM voice.	(see note)	1750 18 preset	27.5 VDC	TM 11-5821-242-series.	Replaces AN/ARC-55 for traffic control communication. Operational ceiling is 70,000 feet.
AN/ARC-54	RT-348/ARC-54 (built-in-retransmission using 2 AN/ARC-54).	30-69.96	FM voice visual read-out for homing.	Line of sight (see note).	800 20 preset	27.5 VDC	TM 11-5821-244-series.	Air-to-ground communication. 50-kHz spacing. Replaces AN/ARC-44. Compatible with first 800 channels of AN/PRC-25 & AN/VRC-12 series.
AN/ARC-51Bx	RT-702/ARC-51Bx	22.50-399.9	Same		3500	27.5 VDC	TM 11-5820-518-20	
AN/ARC-55	RT-349B/ARC-55	225.0-399.9	VHF/UHF AM voice or tone.	(see note)	1750 18 preset	27.5 VDC	TM 11-5821-225-series.	Modified AN/ARC-27 air-to-air and air-to-ground communication. Operates at 25,000 feet. Replaced by AN/ARC-51.
AN/ARC-73	T-17L-7A R-51X-2B	T-116.0- 149.95 R-108.0- 151.95	VHF/UHF AM voice.	(see note)	T: 680 R: 880	27.5 VDC	TM 11-5821-217-series.	General purpose air-to-air and air-to-ground communications. Replaces AN/ART-34 and AN/ART-35.
AN/ARC-95	RT-651/ARC-95	2.0-15.0	AM voice	(see note)	22	27.5 VDC	TM 11-5821-247-series.	Replaces AN/ARC-59. Air-to-air & air-to-ground communications.
AN/ARC-98	Under development	2.0-29.999	AM SSB	240 (see note).	28,000	27.5 VDC	Not published	1 kHz spacing. Compatible with GRC-106 and -108. Will replace AN/ARC-95 and AN/ARC-102.

AN/ARC-102	RT-698/ARC-102	2.0-29.999	AM voice CW SSB.	(see note)	28,000	27.5 VDC	TM 11-5821-248- series.	1 kHz spacing. Com- patible with GRC-106 and -108. Air-to-air and air-to-ground.
AN/ARC-114	Electronically tun- able main receiver & transmitter.	30.00-75.95	FM, clear voice, X-mode.	15,000 ft (max).	920	27.5 VDC	TM 11-5821-259-20	Airborne VHF, FM re- ceiver-transmitter com- patible with VRC-12 series. Has homing capa- bility. Guard receiver is fixed tuned in the 40.0-41.0 MHz fre- quency range. Weight 6.5 lbs. For light air- craft.
AN/ARC-115	Developmental	116.0-149.95	AM voice	(see note)	1360 (25 kHz spacing)	27.5 VDC		A proposed lightweight multichannel airborne radio set (10 lbs). Re- transmission and self- contained guard channel receiver are included. Specifically designed for operation in light obser- vation helicopters. Will be completely solid state. The AN/ARC-115 is to replace the AN/ ARC-73; the AN/ARC- 116 is to replace the AN/ARC-51X.
AN/ARC-116	Developmental	225.0-399.9	AM voice	(see note)	3500 (50 kHz spacing)	27.5 VDC		
AN/ARC-131	RT-832/ARC-131 (Replacement for AN/ARC-54.	30-75.95	FM voice CW, homing retrans- mission is possible if second set is available.	(see note)	920	24-29 VDC	TM 11-5820-670-12	The ARC-54 (800 chan- nels) and the AN/ARC- 131, which is fully com- patible with the ground radios of the VRC-12 series (920 channels), are interchangeable. ARC- 54 is standard B, ARC- 131 is standard A.

NOTE. Range will vary considerably according to the terrain, atmospheric conditions and altitude of the aircraft.

Table 7. Airborne Command Facilities

Equipment	FM sets	SSB VHF or UHF sets	Associated equipment	Remarks
AN/ASC-5 (Airborne tactical operations center).	3 AN/VRC-46	1 AN/VRC-24 1 AN/ARC-102	7 intercom stations (C-1611A/AIC).	May be installed in or removed from aircraft in about 20 minutes.
AN/ASC-6 (Airborne communications center).	2 AN/ARC-54 or 2 AN/ARC-131	1 AN/ARC-51	6 operator stations (C-1611).	Console includes controls for wiring in the aircraft radios (UHF AN/ARC-51, VHF AN/ARC-73, HF SSB AN/ARC-102). A second AN/ARC-51 can be connected into the console, if desired.
AN/ASC-10 (V) (Airborne communications center).	2 AN/ARC-54 or 2 AN/ARC-131 Uses 1 KY-8 or 2 KY-28.	1 AN/ARC-73A or 1 AN/ARC-51BX	6 intercommunication stations C-1611A/AIC 1 KY-8 or 2 KY-28 speech security equipments.	Space is provided to install an HF-SSB AN/ARC-102 control head in the console. Associated antennas, interconnecting cables, and a power cable are provided. Replaces AN/ASC-6. TM 11-5821-276-15.
AN/ASC-11 Airborne communications central; two AN/ASC-11's can be installed in a helicopter UH-1B or UH-1D.	2 VRC-46. Uses 1 KY-8 or 2 KY-28.	AN/ARC-102 of aircraft can be wired into console.	6 intercommunication stations C-1611A/AIC-1-control indicator C-8156/ARC; 2-control indicators C-8157/ARC	Formerly known as the AN/ASC-122. Total weight 225 lbs per unit. TM 11-5821-279-15 (when published). Installed in UH-1B and UH-1D helicopters. One KY-8 with C-8156/ARC, or 2 KY-28 with 2 C-8157/ARC may be installed.
AN/ARC-121 (Airborne relay station).	6 VRC-46		For retransmission	Can retransmit 3 separate net simultaneously.
AN/ARC-122 (Airborne communication control).			3 intercom sets (Airborne CP).	

Table 8. Antenna Equipment

Equipment	Purpose and description	Reference manual	Remarks
AN/GRA-12	Portable half-wave antenna (center-fed Hertz) assembly designed for transmission and reception of radio signals between 1.5 and 18 MHz. It may be used with sets having a power output of less than 500 watts and a characteristic impedance of 52 ohms.	TM 11-2651	Approximate weight: 229 lb
AN/GRA-50	Lightweight doublet antenna kit for transmitters and receivers with a frequency range of 1.5 to 20 MHz not exceeding 100 watts. Uses existing terrain features for supports.	TM 11-5820-467-series	Approximate weight: 12 lb
AN/GRA-4	Portable half-wave antenna assembly designed for transmission and reception of radio signals between 1.5 and 18 MHz. For sets with transmitter output of less than 100 watts. Characteristic impedance of 72 or 500 ohms. Includes two mast assemblies of 16 mast sections each.	TM 11-2651	Approximate weight: 170 lb

RC-292	Elevated wide band modified ground plane antenna designed to operate with and extend range of FM radios operating in frequency range of 20-76 MHz.	TM 11-5820-348-series	Can increase operating range from 50 to 200%.
AT-791 AS-1537 or later developments.	New elevated omnidirectional half-wave antenna being designed to extend range of new family of FM radios. Although several designations for antennas appear as developmental items on current TOE, nomenclature has not yet been firmed up. When standardized, this new antenna is expected to replace the present RC-292.	None published	
AT-984/G	Directional long-wire antenna used to extend range of tactical FM radio sets operating between 30- and 76-MHz frequency range. Also used to overcome electronic jamming. Length is 150 ft (46 meters).	None published (see page 6-4 TM 11-5820-398-12, Nov 65).	Approximate weight: 12 oz.
AS-1729/VRC	10-ft center-fed whip antenna with automatic matching unit. Component of new family of vehicular-mounted FM radios. An improved version of the AT-912/VRC. Matching unit automatically adjusts electric length of antenna to selected operating frequency.	TM 11-5820-402-series	Replacement for AT-912A/VRC
AT-784/PRC	This is a homing loop antenna. It is used for the detection and location of radio signals in the 30- to 76-MHz range.	TM 11-5895-284-15	
Log-periodical antenna.	A special antenna designed for a specific frequency band to obtain a high quality radiation pattern and impedance characteristics which are essentially uniform throughout its entire operating band. Such an antenna can be constructed for omnidirectional use, or the antenna array can be designed to conform to a specific and preselected degree of directional angularity.	None	This type antenna is used with AN/GRC-163 when long range (50 km) operation is desired.
AB-903/G mast	Mast AB-903/G is a lightweight, telescopic, cable-driven mast which provides the means to raise such antennas as antenna AS-1729/VRC to 30 feet above ground level. The retracted height of the mast is 72 inches. The mast may be set up on the ground or may be mounted on vehicles. It may be raised to full height by hand cranking.	TM 11-5985-263-12	Consists of six concentric tubes sliding on low friction brush- ings. Mast is raised or lowered by a cable system operated by a gear-driven winch.

Table 9. Communications Security Equipment

Equipment	Purpose and description	Remarks
TSEC/KL-7 (electro-mechanical literal cipher machine).	An off-line electromechanical, portable, keyboard operated, tape printing cipher machine which encrypts literal and digital text.	Requires 24 volts DC or 115/230 volts AC for operation.
TSEC/KW-7 (electronic tactical teletypewriter security equipment)	An on-line, electronic, portable, synchronous, half-duplex, teletypewriter security equipment used for securing tactical point-to-point or netted communications.	Requires 21-31 volts DC or 115/230 volts AC for operation.
KLX-7/TSEC (keyboard adapter)	A keyboard adapter which, together with the TSEC/HL-1, provides the KL-7 with an automatic encryption or decryption capability from punched teletypewriter tape.	No power required. Employed where requirement exists for handling large volumes of KL-7 encrypted traffic.

Table 9. Communications Security Equipment—Continued

Equipment	Purpose and description	Remarks
TSEC/HL-1 (electromechanical tape reader for literal cipher machine)	An electromechanical off-line tape reader converter which, together with the KLX-7, provides the KL-7 with an automatic encryption or decryption capability from punched teletypewriter tape.	Requires 115/230 volts AC for operation. Employed where the requirement exists for handling large volumes of KL-7 encrypted traffic.
TSEC/KY-8 speech security equipment	Used with FM radio equipment.	
TSEC/KY-28 speech security equipment	Used with FM radio equipment mounted in aircraft.	
TSEC/KY-38 speech security equipment	Used with FM radio equipment in certain configurations.	

Table 10. Remote Control Devices

Equipment	Purpose and description	Distance limitation	Power requirement	Reference manual
Radio set control group AN/GRA-6	Can be used to perform the following functions: 1. Controlling and operating old FM sets from a distance. 2. Controlling AM SSB radio sets and voice portion of AM SSB radio teletypewriter equipment. 3. Two-way telephone communication between remote and local operators. 4. Local control of radio sets.	Approximately 3 km with WD-1/TT wire	4 BA-30, 1 BA-414/U	TM 11-5038
Radio set control group AN/GRA-39	A transistorized battery operated, remote control system providing duplex telephone operation and two-way signaling for the operation of the AN/VRC-12 and AN/PRC-25 series of FM radio sets from a remote location. Built-in loudspeaker and audio power amplifier	Approximately 3 km with WD-1/TT wire	6 BA-30 for each unit	TM 11-5820-477-12
Radio set control group AN/GSA-7	A small, lightweight, electronic switching unit which can be used as follows: 1. Provides electronic switching for use in integrated radio/wire system. 2. Connects radios with local battery telephone equipment on a push-to-talk basis. 3. Interconnects two push-to-talk radio sets for automatic relay (two sets required). 4. Provides operator facilities for listening, signaling or talking to either or both ends of the circuit.	Approximately 16 km, using WD-1/TT wire	24 VDC 115 or 230 VAC self-contained	TM 11-5135-15

NOTE. Cable CX-7474=U must be used to make the AN=GSA-7 compatible with the VRC-12 series of radios. This cable interconnects the 10-pin and 5-pin cable connectors.

Radio set control group OA-1754/GRC	Radio set control group OA-1754/GRC is designed to permit remote CW operation of the radio set AN/GRC-19 and remote CW and FSK (teletype) operation of the radio teletypewriter sets AN/GRC-46 and AN/VRC-29. This device is used in conjunction with control group AN/GRA-6. The OA-1754/GRC consists of a local unit and a remote unit.	1.6 km	Furnished by set to which this equipment is connected	TM 11-5820-389-12P, C-1
Oscillator, audio frequency, O-574/GRA	The oscillator, audio frequency O-574/GRA is a selfcontained 1600-Hz signal generator. It may be used in conjunction with the AN/GSA-7 to permit a radio set operator to signal a telephone that is connected to an unattended AN/GSA-7. When used with the new series radios, a cable CX-7474/U must be used which converts the 10-pin contacts on one end to 5-pins on the other end. Used for radio/wire integration.		4 BA-1312/U	TM 11-5135-15 C-3
Control, remote retransmission unit C-7772/GRC (under development) (Bilateral retransmission unit)	Adapts squad radio set (AN/PRC-88) for retransmission with AN/PRC-25, AN/VRC-12 series and AN/GRA-39. It permits a commander to communicate over his normal telephone or radio set, even though separated from it by distances of one-half mile or more. To do this, he carries a squad radio set AN/PRC-88 for communication with another PRC-88 which is coupled to his radio set or his telephone network through control C-7772/GRC. Two frequencies are required with a minimum channel separation of 2 MHz.	1.6 km	Furnished by PRC-88	
Radio control group AN/GRA-74	This equipment is comprised of a local unit, C-4846()/GRA-74 and a remote unit, C-4847()/GRA-74. This permits operation of the radio sets from a remote site of 1.6 km. The units provide a four wire communication link with transmit and receive facilities of SSB, CW and AM between the remote unit and the radio set. Used with AN/GRC-106, 108, 122, and 142, and AN/VSC 2 and 3.	1.6 km		Developmental item to replace the AN/GRA-6 now used with SSB radio sets.

Table 11. Switchboards

Equipment	Number of lines accommodated	Type of operation	Power requirements	Major components	Reference manual	Remarks
AB-993/GT	6	Manual local battery	None	1 MT-2156/GT 7 U-184/GCT	TM 11-5805-294-15	Emergency switching center, uses visual signaling.
SB-22/PT and SB-22A/PT	12	A portable, local, battery, monocord switchboard, capable of connecting 12 local battery telephone circuits, remote controlled radio circuits, or voice frequency teletypewriter circuits. Uses magneto signaling.	4 BA-30	1 SB-22/PT 1 MX-230/PT (3 spare line packs) (MX-2915/PT for SB-22A)	TM 11-5805-262-12	SB-22A differs from SB-22 in contents of accessory kit. The kit for for SB-22A (MX-2915/PT) contains 2 line packs, 1 trunk pack. By stacking 2 or 3 SB-22 switchboards, the number of circuits can be increased to 29 or 46, respectively.

Table 11. Switchboards—Continued

Equipment	Number of lines accommodated	Type of operation	Power requirements	Major components	Reference manual	Remarks
SB-86/P	30, including 2 civilian trunks	A complete, transportable, single-position, nonmultiple, local battery tactical switching central capable of terminating 30 magneto or common battery signaling lines or trunks, two of which may be automatic one-way ring-down trunks to civilian exchanges. Can be used for voice frequency teletypewriter circuits. Includes a switchboard section, jack field switchboard signal assembly TA-207/P, and power supply PP-990/G.	4 BA-30, 10 BA-200/U	1 SB-248/P 1 TA-207/P 1 PP-990/G	TM 11-2134 TM 11-4134	Expansible to 60 lines with the addition of switchboard signal assembly TA-207/P. Cannot be used directly for radio/wire integration; for this purpose a switchboard, SB-22 is used in conjunction with the SB-86.
SB-223/GR (switchboard signal assembly)	12 microphone lines, 6 recorder channels, 4 telephone lines	Manual, no ringing on switchboard	BB-53 or other source of 12 VDC	SB-223/GR	TM 11-2149	Used by sound ranging platoon of target acquisition battery. Connects 2 soundbases to sound ranging set GR-8.
MX-155/GT telephone connecting and switching group	Total of 10 (1 circuit of 2, 1 circuit of 8)	Manual	None	1 jack panel SB-16/GT, 7 reel brackets, 7 jacks U-17/GT, 15 cords CX-231/GT	TM 11-2546	Provides conference telephone circuits among battery XO, assistant XO, and 6 howitzer or gun sections.

Table 12. Radio Terminal Sets and Associated Equipment

Equipment	Purpose and description	Reference manual	Remarks
AN/TRC-80 radio terminal set	Mobile, air-transportable, tropospheric scatter radio terminal set: 1 transmitter: Amplifier-modulator group OA-3832/TRC-80 2 receivers: Radio receiver group OA-3831/TRC-80 1 Power Unit: 120/208 VAC, 3-phase, (built-in) 400-hertz, 10-kw Frequency range, 4,400-5,000 MHz (SHF) FM voice & teletype Planning range: 160 km using dual diversity, 110 km using nondiversity. *333 channels, 1.8-MHz spacing	TM 11-5820-469-series	Peculiar to field artillery Pershing battalion for internal communications. Uses inflatable parabolic antenna, 96 inches in diameter. *Being modified to provide 12,000 channels at 50-kHz spacing. (AN/TRC-80A).
AN/TSA-15 telegraph-telephone switchboard group	Mobile switching facility capable of interconnecting 5 half-duplex, 2-wire voice frequency teletype circuits and 29 telephone circuits: 1 shelter S-141 on 2½-ton vehicle 3 SB-22 switchboards (stacked) 4 teletypewriters TT-4/TG 6 telegraph terminals TH-5/TG 6 signal converters TA-182/U 1 patch panel	TM 11-5805-352-15 (1967)	Used at Pershing battalion headquarters battery to interconnect all AN/TRC-80 terminal sets and provide circuits into the army area system and to higher headquarters.

	2 teletypewriters TT-76/GGC 1 generator set PU-474/M (2 units of 10 kw each)	Rack & cabling for 5 sets of on-line security equipment (5 TSEC/KY-7's are used with but are not part of this equipment)		
AN/TRC-24	Transportable, multichannel, VHF-UHF radio set used at division, corps, and army level to provide high quality, high capacity tactical communication. Intended to replace wire where quick installation is required. A basic unit in various configurations of terminal and repeater sets in radio relay systems. Frequency range is divided into 7 separate bands, ranging from 50 to 1875 MHz. Planning range is 48 km. Will eventually be replaced by AN/GRC-50 (V).	TM 11-5830-287-series	Major components: 1 R-417/TRC-24 1 T-302/TRC-24	
AN/GRC-50 (V)	Mobile UHF radio transmitting and receiving equipment for use with multichannel carrier telephone terminal apparatus such as terminal telephone AN/TCC-7; FM, covers 2 frequency bands: 600 to 1000 MHz and 1350 to 1850 MHz. Used with 4-, 12-, or 24-channel frequency division multiplex (FDM) or 12- or 24-channel time division multiplex (TDM) equipment (pulse code modulation) to provide telephone, teletypewriter, data, or facsimile circuits. Multiplex equipment used with this set will determine the number of channels. Planning range is 48 km. Consists of the following: Transmitter T-893(P)/GRC Receiver R-1148(P)/GRC Power supply PP-2054/GRC	TM 11-5820-461-series Power supply PP-2054/GRC Voltage regulator GN-514/GRC Power unit PU-294/G (consists of 2 PU-286/G, 5 kw)	Replaces AN/TRC-24 radio set in many applications of area system components.	
AN/MCC-6 telegraph- telephone terminal	Mobile telegraph terminal, 24 channels of carrier telephone or 22 carrier telephone and two 8-channel telegraph systems. (Other combinations of voice and teletype utilization are possible). Components: 1 shelter S-185/MCC-6 1 telephone terminal TCC-7 1 telephone terminal TCC-50 8 filters F-98/U	2 telegraph terminals TCC-4 1 telegraph terminal TH-5/TG 1 teletypewriter TT-4/TG 28 signal converters TA-182/U 1 set trailer-mounted gas engine generator PU-474M (2 units of 10 kw each)	TM 11-5805-285-15	Used in division, corps, and army area communication systems.
AN/MGC-17 central office teletypewriter	Mobile central office, containing facilities for two full-duplex or half-duplex teletypewriter circuits including one secure circuit, and switching facilities for 12 subscriber lines. Two sets of on-line security equipment can be used. The components are as follows: 1 shelter S-169/MGC-17 1 switchboard SB-22A/PT 3 telegraph terminals TH-5/TG 6 signal converters TA-182/U	2 teletypewriters TT-4A/TG 2 teletypewriters TT-76B/GGC 1 trailer mounted, gas engine generator PU-322/G (2 PE-75, 5 kw each)	TM 11-5815-205-15 (MWO 11-5815-205-30/1 has added one TT-4A/TG)	Used in division area communication system. Used by HQ Btry of corps arty and Sergeant Bn. Used in each btry of Pershing bn to terminate the terminal set AN/TRC-80. Security equipment is not part of this set.
AN/TSC-58 terminal telegraph	A mobile telegraph terminal, providing three full-duplex or six half-duplex secure voice frequency teletypewriter circuits or providing six nonsecure full-duplex or six nonsecure half-duplex voice frequency teletypewriter circuits. Consists of the following: 1 shelter S-348/TSC-58 8 terminals telegraph, TH-22/TG 1 telephone TA-312 1 interphone set LS-147/FI	6 teletypewriters TT-76/GGC 6 teletypewriters TT-98/GF 1 switchboard SB-22/PT 2 air conditioners 9,000 BTU 1 generator set, gas engine PU-619M (2 each 10 kw units)	TM 11-5895-462-15 (when published)	Will replace the old telegraph terminal AN/MS-29.

Table 12. Radio Terminal Sets and Associated Equipment—Continued

Equipment	Purpose and description	Reference manual	Remarks
AN/MSC-29 terminal telegraph.	A mobile telegraph terminal providing 8 full-duplex or 12 half-duplex nonsecure voice frequency teletypewriter circuits or providing 2 full-duplex or 4 half-duplex secure circuits. Also provides switching facilities for 16 subscriber telegraph circuits. Consists of: 1 shelter S-176/MSC-29 1 switchboard SB-22A/PT 8 signal converters TA-182/U 4 filters F-98/U mounting racks, & cabling for on-line security equipment	TM 11-5895-205-12	Used in division, corps, and army area communication systems. Also used in FDC of corps arty. Security equipment is not part of this set. Will be replaced by an improved model, AN/TSC-58.
AN/MRC-69 (V) radio terminal	Mobile radio relay terminal set operating in frequency band of AN/TRC-24 or AN/GRC-50. Provides two 12-channel radio relay terminals or one 12-channel radio relay terminal and one 12-channel land line carrier terminal. FM, line of sight, planning range 48 km. Components: 1 shelter S-141 or S-178/MRC-69 2 radio sets AN/TRC-24 or AN/GRC-50 (V) 2 telephone terminals TCC-7	TM 11-5820-204-15	Provides trunking facilities in a division area communication system. Commercial power can be used. Frequency ranges are— AN/TRC-24 A-band 50- 100 MHz B-band 100- 225 MHz C-band 225- 400 MHz D-band 400- 600 MHz F-band 790- 925 MHz J-band 1350-1875 MHz AN/GRC-50 Low band 601.5-999.5 MHz High band 1350.5-1845.9 MHz
AN/MRC-115 (V) radio terminal set	The radio terminal set AN/MRC-115 (V) is an interim configuration of the low capacity subsystem of the army area communication system (AACOMS). It is an assemblage which provides a dual 6/12 channel terminal mounted on a ¼-ton trailer V-397()/MRC-115. It can be used as a single terminal, double terminal, or a radio repeater as required. As a radio terminal, it is capable of terminating two 12-channel systems, and as a radio repeater, it is used in a single 12-channel system. The assemblage will be moved by a ¼-ton vehicle and powered by two 1.5-kw gasoline engine generators, mounted on a pallet, and carried in the ¼-ton vehicle. The major components of the terminal set are as follows: 2 radio sets AN/GRC-103 2 multiplexers TD-660/G Radio set AN/GRC-103 is a VHF/UHF radio set which is capable of operating with its associated PCM multiplex unit to provide 6/12 voice channels over one relay. The AN/GRC-103 consists of receiver R-1329, transmitter T-983, order wire RT-773, mast AB-952, and antenna AS-1852. Frequency range is 220 to 1000 MHz in three bands (total of 2160 channels). Planning range is 32-48 km.	TM 11-5895-585-15	This terminal set is intended for use by forward area units at division level down to bde and in the field army air defense artillery units. Lightweight and small size make this system uniquely suitable for air-transportable units. Weight of assemblage in trailer is 1,830 lb. Weight of power unit (2 generators) is 280 lb. The letter "(V)" indicates that variations of the radio equipment components are available to the user.
AN/MRC-68 (V) radio terminal set	Mobile radio terminal set installed in a S-144/G shelter which is mounted on a ¾-ton vehicle. Provides one 4-channel radio relay or two 4-channel radio terminals or provides two 4-channel radio-telephone carrier terminals or two 4-channel carrier terminals. Components:	TM 11-5820-505-15	For use in army mobile communication systems. This system is capable of being airborne. 54.0 to 70.9 MHz, 170 channels, 100 kHz spacing.

	3 AN/GRC-10 radio sets (2 in use, 1 spare)	2 terminals AN/TCC-3 9 signal converters TA-182/U 1 PU-322/G (2 each PE-75)		
AN/MRC-54 (V) radio repeater set	Mobile VHF-UHF radio relay repeater set, operating in the frequency range of the AN/TRC-24 or AN/GRC-60 (V). Can be used in conjunction with AN/MCC-6 as terminal set. Planning range is 48 km. Components: 1 shelter S-177/MRC-54 (V) 3 radio sets AN/GRC-50 (V) or AN/TRC-24 (1 spare)		TM 11-5820-203-15	Used in division, corps and army area systems.
		1 set trailer mounted gasoline engine generator PU-474/G (two 10-kw sets)		
AN/MRC-73 (V) radio terminal set	An air- or vehicular-transportable radio terminal set, VHF-UHF, that can provide 12 channels of carrier telephone or 11 channels of carrier telephone and 4 channels of carrier telegraph over spiral-4 cable or radio. Uses AN/TRC-24 or AN/GRC-50 radio set. Planning range is 48 km. Components: 1 shelter S-181/MRC-73 1 radio set AN/TRC-24 or AN/GRC-50 (V) 1 telephone terminal TCC-7 1 telephone terminal TCC-20		TM 11-5895-221-15	Used in corps and army radio-relay communication.
		1 telegraph terminal TH-5/TG 1 teletypewriter TT-4A/TG 12 signal converters TA-182/U 1 gasoline engine generator PU-474/G (two 10-kw sets)		
AN/GRC-103 (V) 1	Radio set AN/GRC-103 (V) 1 is a transportable radio relay set that provides facilities for multichannel radio transmission and reception of pulse-code modulation signals. The radio set operates in the frequency range of 220 to 404.5 MHz in any one of 370 radio frequency channels selectable in 0.5-MHz increments. The radio set will accommodate up to 24 telephone channels when used with the appropriate PCM multiplex equipment. Planning range is 80 km. Components: 1 transmitter, radio T-983(P)/GRC-103(V), with amplifier-frequency multiplier AM-4320. 1 receiver, radio R-1329(P)/GRC-103(V), with amplifier-converter AM-4316 1 antenna AS-1852/GRC-103(V) 1 receiver-transmitter, order wire, RT-773/GRC-103(V) Power requirements: 115 volts AC, single phase, 47 Hz to 420 Hz		TM 11-5820-540-12	Forward area radio-relay equipment. Can also operate in frequency bands 395 to 705 and 695 to 1000 MHz.
AN/MRC-102 radio terminal set.	The AN/MRC-102 is a radio carrier assemblage used to provide radio relay, carrier telephone, and carrier telegraph facilities in an area type communication system. It has the same capabilities as, and may be used in place of the AN/MRC-73. The major components are— 1 shelter, elec equipment S-306/MRC-102 (modified S-141/G) 2 radio sets AN/GRC-50 1 terminal, telephone AN/TCC-7 1 terminal telegraph AN/TCC-20 12 converters, tg-tel signal, TA-182/U 1 telephone set TA-312/PT 1 teletypewriter TT-4A/TG 1 terminal, telegraph TH-5/TG 1 intercom set LS-147/FL		TM 11-5895-357-14	Mounted on truck cargo 2½-ton, M35 or M211. Requires 5452 watts, furnished by trailer-mounted gas engine generator set PU-474M. Used by the command artillery radio relay company of the corps sig bn in support of corps artillery.

Table 12. Radio Terminal Sets and Associated Equipment—Continued

Equipment	Purpose and description	Reference manual	Remarks
AN/MRC-103 radio repeater set.	The AN/MRC-103 as a radio repeater provides retransmission facilities for 12 channels of radio-telephone communication when used with radio terminal set AN/MRC-102, terminal telegraph-telephone AN/MCC-6 and terminal telephone AN/TCC-7. It has the same capabilities as, and may be used in place of the AN/MRC-54. The major components are as follows: 1 shelter, elec equipment S-307/MRC-103 (modified S-141/G) 3 radio sets, AN/GRC-50 3 antenna sets for AN/GRA-50 1 telephone set TA-312/PT 1 intercom set LS-147/FL	TM 11-5820-539-14	Mounted on truck cargo 2½-ton, M35 or M211. Requires 5340 watts, furnished by trailer-mounted gasoline engine generator set PU-474M. Used by the command artillery radio relay co of the corps sig bn in support of corps artillery.

Table 13. Teletypewriter Equipment

Equipment	Purpose and description	Reference manual	Remarks
TT-4()/TG teletypewriter.	This teletypewriter is used to transmit teletypewriter messages in the form of direct current teletypewriter signals and to convert received direct current signals into messages, printed on a roll of recording paper (one-, two-, or three-ply).	TM 11-5815-206-12	Used in tactical military communication systems.
AN/PGC-1	The AN/PGC-1 is a lightweight transportable unit. It consists of teletypewriter TT-4()/TG, connecting cables, and a bag of spare parts.	TM 11-5815-206-12	Same as TT-4()/TG. In a typical voice frequency system, telegraph terminal TH-5/TG or TH-22/TG must be used at both ends.
TT-335/TG	This teletypewriter is the same as the TT-4()/TG except that in the TT-4()/TG, 105 or 125 volts DC or AC (50-60 hertz) single-phase is required, whereas the TT-335/TG is powered for 108 to 132 volts, 396 to 404 hertz, single-phase synchronous power.	TM 11-5815-206-12	Used in the Pershing bn in each AN/TRC-80 terminal set.
TT-537/G	In a typical FADAC system, low voltage signals from the computer are applied to the receive circuits of the teletypewriter TT-537/G where they are amplified to the level required to operate the selector magnet in the teletypewriter receive mechanism. The motor of this teletypewriter is designed for operation with 108 to 132 volts, 396 to 404 hertz alternating current.	TM 11-5815-206-12 (C-8)	Used as a printout in conjunction with FADAC. Replacement for teletypewriter TGC-14 now shown on some TOE's.
AN/UGC-4 teletypewriter.	Page printing, sending and receiving machine. Operates from 110 volts AC, single phase, 60 hertz. The AN/UGC-4 consists of teletypewriter TT-98()/FG and power supply PP-978/FG.	TM 11-5815-200-10	Used in tactical radio teletypewriters (also part of AN/GRC-26 radio set).
TT-76/GGC reperforator-transmitter.	The TT-76/GGC is a lightweight transportable teletypewriter that may be used to send and receive over direct current wire lines, carrier, or radio systems in association with telegraph terminal TH-5/TG or TH-22/TG. Messages are printed and perforated on a paper tape. It provides facilities for manual transmission direct from keyboard and for tape transmission from the transmitter-distributor. Operates on 115 or 230 volts AC.	TM 11-5815-238-12	Used in fixed or tactical military teletypewriter stations.

AN/GGC-3	The AN/GGC-3 consists of a reperforator-transmitter TT-76()/GGC, a table FN-52/GGC, and a case CY-1100/GGC.	TM 11-5815-238-12	Used in fixed or tactical military teletypewriter stations.
AN/TCC-14 telegraph-telephone terminal.	Consists of three separate components, the combination of which permits simultaneous transmission of telegraph pulses and speech over a voice frequency circuit. The three components, which can be used separately for various applications are as follows: <i>Telegraph terminal TH-5/TG</i> Modulates DC teletype pulses to 1225- and 1325-Hz frequencies and back to DC pulses at the other end of the circuit. It provides only one-way reversible operation. <i>Telegraph-telephone signal converter TA-182/U</i> Modulates 20-Hz ringing signals either to 1225 Hz for teletype signaling or to 1600 Hz for telephone circuits. The unit at the far end of the circuit reverses this process. <i>Filter assembly F-98/U</i> The band-pass and band-stop sections of the filter separate the teletypewriter and telephone conversation. This permits simultaneous transmission of teletype and telephone messages over the same pair of wires without mutual interference.	TM 11-5805-254-15 11-5805-247-10 11-5805-246-10	The AN/TCC-14 can be used in point-to-point, network, switched, or remote control radio system. Will be replaced by the fully transistorized AN/TCC-29. The components of both systems are fully compatible.
AN/TCC-29 telegraph-telephone terminal.	The AN/TCC-29 serves the same purpose as the AN/TCC-14 described above. Its components are as follows: Telegraph terminal TH-22/TG Telegraph-telephone signal converter CV-425/U Filter assembly F-316/U	TM 11-5805-356-12	Transistorized version of the AN/TCC-14. Will replace the AN/TCC-14 and its 3 components. Components of old and new systems are interchangeable and fully compatible.

Table 14. Power Units

Equipment	Power output	Mounting	Weight (lb)	Remarks
PU-26A	10-kw 120/240 VAC, 60-Hz 3-phase	skid	1,250	
PE-75-AF	2.5-kw, 120 VAC, 60-Hz, single-phase	skid	298	
PE-95-A-B-C or F models.	5-kw, 120/240 VAC, 60-Hz, single-phase	skid	1,545	
PE-95-G-H-I or K models.	10-kw, 120/240 VAC, 60-Hz, single-phase	skid	1,556	
PU-286()/G	5-kw, 120 VAC, 60-Hz, single-phase	skid	769	
PU-290/MR	10-kw, 120 VAC, 60-Hz, single-phase	1½-ton trailer	4,000	One 10-kw generator set mounted in a 1½-ton cargo trailer.
PU-294	5-kw, 120 VAC, 60-Hz, single-phase	1½-ton trailer	4,400	Two power units PU-286()/G mounted in a 1½-ton cargo trailer. Load can be shifted from one PU-286 to the other without interruption.
PU-322/G	2.5-kw, 120 VAC, 60-Hz, single-phase	¾-ton trailer	2,350	Two power units PE-75-AF mounted in a ¾-ton cargo trailer.

Table 14. Power Units—Continued

Equipment	Power output	Mounting	Weight (lb)	Remarks
PU-378	10-kw, 120/240 VAC, 60-Hz, 3-phase	1½-ton trailer	3,650	Two power units PU-26A mounted in a 1½-ton cargo trailer.
PU-407/M	45-kw, 120/240 VAC, 50-60 Hz, 1- or 3-phase.	2½-ton trailer	7,500	One 45-kw power unit mounted on chassis trailer, 2½-ton M200A1 (diesel).
PU-408/M	45-kw, 120/240 VAC, 50-60 Hz, 1- or 3-phase.	Truck, cargo, 5-ton	27,560	One generator set PU-407 (diesel) mounted on a 5-ton cargo truck M54.
PU-409	5-kw, 120 VAC, 60-Hz, single-phase	¾-ton trailer	2,065	One power unit PU-286()/G mounted in a ¾-ton trailer.
PU-450/G	3-kw, 120/240/208 VAC, 400-Hz, 1- or 3-phase.	skid	215	Provides power for communication or radar equipment.
PU-456	5-kw, 120 VAC, 60-Hz, single phase	¾-ton trailer	2,800	Two power units PU-286()/G mounted in a ¾-ton cargo trailer.
PU-474	10-kw, 120/240 VAC, 60-Hz, 1- or 3-phase	1½-ton trailer	8,770	Two 10-kw power units mounted in a 1½-ton trailer.
PU-332A/G	1-10 kw unit	¾-ton trailer	3,400	Used with AN/TRC-112.
PU-405	1-15 kw unit	2½-ton trailer	5,465	Used with AN/TRC-121.
PU-618/M	2-5 kw units	1½-ton trailer	4,600	Used with AN/TRC-110, AN/TRC-117.
PU-619/M	2-10 kw units	1½-ton trailer	6,160	Used with AN/MGC-19A (operations central teletypewriter).
PU-623/VRC-59	2-1½ kw units and ancillary items for VRC-59.	¼-ton M416 trailer	1,825	Used with AN/VRC-59.
PU-625/G	2-3 kw units	¾-ton trailer	2,900	Used with AN/TRC-113, AN/TRC-145.
PU-626()/G	2-3 kw units and ancillary units	¾-ton trailer	2,900	Used with AN/TRC-108, AN/TRC-109, AN/TRC-143.
PU-628()/G	2-3 kw units	¾-ton trailer	2,900	Used with AN/MTC-7A (central office, telephone, manual).
PU-629()/G	2-5 kw units	1½-ton trailer	5,000	Used with telephone terminal AN/TCC-61, AN/TCC-62, AN/TCC-63.
PU-631()/G	2-5 kw units	1½-ton trailer	5,500	Used with AN/TRC-111, AN/TRC-138, AN/TRC-139, AN/TRC-140.

*Note. The following are additional power units for new army area communications system.

Table 15. Reeling Equipment

Equipment	Purpose and description	Reference manual	Remarks
RL-27-B-C, or D axle, cable reel.	An 8-pound machined-steel bar, 2½ feet long with 2 knurled handles. It is used to recover and lay short wire circuits by hand.	TM 11-3895-201-13P	
RL-31() reeling machine, cable, hand.	A rugged, lightweight portable unit for laying and recovering telephone cable, using cable reel RL-159 (1-mile capacity).	TM 11-362	Can be mounted in a vehicle or hand-carried.
RL-39 reeling machine, cable, hand.	Reeling machine, cable, hand, RL-39, is used with cable reel DR-8 (¼-mile capacity).		
RL-172/G reeling machine, cable, motor driven.	RL-172/G is a transportable wire-laying and recovering machine that can be mounted on a motor vehicle. The reeling machine is normally mounted vertically on the tailgate of a truck. May also be operated horizontally from the bed of a truck.	TM 11-3895-207-10	Vehicle battery provides the power to operate the 24-volt direct current motor of the machine. Also has handle for manual operation.
RL-207/G reeling machine cable, engine driven.	RL-207/G is a two-cylinder gasoline engine driven reel unit mounted in a ¾-ton truck or larger vehicle to pay out or recover telephone cable or spiral-4 cable.	TM 11-3895-209-12	The machine has 2 axles; each axle will accommodate 2 RL-159, 1 DR-5, or 1 DR-15 reel.

Table 16. Basic Items of Test Equipment

Equipment	Purpose and description	Reference manual	Remarks
AN/GRM-55 test set, electronic circuit plug-in unit	The radio test set is a compact, lightweight, waterproof instrument designed to make tests at all available test points of receiver-transmitter RT-505/PRC-25 and to isolate a failure to a particular module. The AN/GRM-55 is issued for use by radio mechanics.	TM 11-6625-514-12	Cannot be used with AN/PRC-77 (RT-841).
ME-26()/U multimeter	Multimeter ME-26()/U is an electron tube instrument (voltmeter-ohmmeter) that is used to measure direct current voltage, resistance, and alternating current voltage at frequencies from 20 Hz to 700 MHz. When used as a voltmeter, the high input impedance of the multimeter permits measurements to be made without affecting either the voltage being tested or the operation of the equipment under test.	TM 11-6625-200-12	The voltage ranges are—7 scales for DC voltage from 0 to 100 volts, 6 scales for AC voltage from 0 to 300 volts. The resistance range is from 0 to 500 megohms.
TS-352()/U multimeter	The TS-352()/U is a volt-ohm milliammeter that uses self-contained batteries (3 BA-31 and 1 BA-30). It measures alternating current voltages (0 to 1000) and direct current voltages (0 to 5000) and measures resistance from 0 to 10,000,000 ohms. It also measures direct current in microamperes and milliamperes to a maximum current of 10 amperes.	TM 11-6625-366-15	Multiplier kit MX-815()/U is part of the TS-352 and extends the range of the instrument to allow measurement of the higher DC voltages.
TV-7()/U test set electron tube	Test set, electron tube TV-7()/U is a portable tube tester of the dynamic mutual conductance type. It is used to test and to measure performance capabilities and to determine rejection limits for electron tubes used in receivers, low-powered transmitters, and much other electronic equipment.	TM 11-6625-274-12	Tubes can be tested for continuity, dynamic mutual conductance, emission, gas, noise, and shorts.

Table 16. Basic Items of Test Equipment—Continued

Equipment	Purpose and description	Reference manual	Remarks
AN/VRM-1 test set, radio	Test set AN/VRM-1 is a portable equipment for testing the plug-in modules of receiver-transmitters RT-246/VRC and RT-524/VRC and the receiver R-442. This instrument is used by organizational maintenance personnel responsible for maintaining the components of radio set AN/VRC-12 and radio sets AN/VRC-43 through 49.	TM 11-6625-496-12	This test equipment is designed to operate on a simple GO and NO GO basis—a green light indicates a serviceable module; a red light, a defective module.
AN/URM-105 multimeter	Multimeter AN/URM-105 consists of multimeter ME-77/U and 4 test clips. It requires 2 BA-58/U; and 1 BA-261/U for proper operation. The instrument measures direct current and alternating current voltage from 0 to 1000 volts and resistance from 0 to 20,000,000 ohms.	TM 11-6625-203-12	Meter can be used for making other measurements, provided external shunts are used: MX-1471/U for current measurements up to 10 amp, MX-1472/U for voltage measurements up to 10,000 volts, MX-2005/U for voltage measurements up to 50,000 volts.

Table 17. Major Components for New Army Communication System (AACOMS)

Equipment	Purpose and description	Remarks
AN/TRC-108 radio terminal set.	Radio terminal set AN/TRC-108 is an air- or vehicular-transportable radio carrier assemblage used to provide terminal telephone multiplexing facilities 12-channel pulse-code modulation for use by airborne corps and corps artillery communications systems. ($\frac{3}{4}$ -ton vehicle).	Uses 2 radio sets AN/GRC-50(V) 1 and power unit PU-626()/G. (TM 11-5820-537-15).
AN/TRC-109 radio repeater set.	Radio repeater set AN/TRC-109 is an air- or vehicular-transportable assemblage used to provide radio and cable communications facilities for use by airborne corps communications systems. The assemblage may be used in 12- or 24-channel pulse-code modulation systems as a cable repeater, a radio repeater, or a radio terminal or in special applications. The AN/TRC-109 can be used with other equipments, such as telephone terminal AN/TCC-60. ($\frac{3}{4}$ -ton vehicle).	Uses radio set AN/GRC-50(V) 2 and power unit PU-626()/G. (TM 11-5820-536-14).
AN/TRC-110 radio repeater set.	Radio repeater set is an air- or vehicular-transportable assemblage used to provide radio and cable communications facilities for corps and army command systems. The assemblage may be used in 12- or 24-channel pulse-code modulation systems as a radio repeater, a radio terminal, or a cable repeater. (2 $\frac{1}{2}$ -ton vehicle, 6 x 6 LWB).	Uses radio set AN/GRC-50(V) 4 and power unit PU-618M. (TM 11-5820-535-14).
AN/TRC-111 radio repeater set.	The AN/TRC-111 is a 48-96 channel radio repeater or a triple 48/96 channel radio terminal assemblage. Sufficient auxiliary equipment is provided for a high capacity radio relay or radio terminal facility. (2 $\frac{1}{2}$ -ton truck, 6 x 6 LWB).	Uses radio set AN/GRC-147 (which consists of 1 $\frac{1}{2}$ AN/GRV-68 radio sets having a total of 3 transmitters and 3 receivers and power unit PU-631()/G). (TM 11-5820-546-15).
AN/TRC-112 radio terminal set.	The AN/TRC-112 is an extended-range radio terminal. It can transmit 24 PCM voice channels for distances ranging up to 160 kilometers and single-channel voice plus teletypewriter up to 320 kilometers. It also provides 1-kw RF output, dual space and angle diversity, low noise receivers, and two 10-foot quick erection antennas carried in a separate 1 $\frac{1}{4}$ -ton M705 vehicle. Operates in the troposcatter mode. (2 trucks, cargo 1 $\frac{1}{4}$ -ton).	Uses radio sets AN/GRC-143 and AN/GRC-106 (for alinement of tropo) and power unit PU-332A/G. (TM 11-5820-556-15).

AN/TRC-113 radio repeater set.	The AN/TRC-113 is a radio relay repeater to extend the range of a radio circuit employing two radio sets AN/GRC-103. It also contains one extra, or spare, radio set AN/GRC-103. It may also be used as a radio terminal to provide three radio circuits. A 6/12 channel radio repeater. (1 truck, cargo 1¼-ton).	Uses three radio sets AN/GRC-103 power unit PU-625/G. (TM 11-5820-562-15).
AN/TRC-117 radio terminal set	Radio terminal set AN/TRC-117 is an air- or vehicular-transportable assemblage used to provide dual 12- or 24-channel pulse code modulation for use by army and corps command systems. (1 truck, cargo, 2½-ton, 6 X 6 LWB).	Uses radio set AN/GRC-50(V) 2 and power unit PU-618/M. (TM 11-5895-366-14).
AN/TRC-121 radio terminal set	Radio terminal set AN/TRC-121 is a dual extended-range radio terminal. It is capable of terminating two 24-channel PCM voice systems for distances ranging up to 192 kilometers. It also provides 1-kw RF output, dual space diversity, low noise receivers, and two 10-ft antenna systems, carried in a separate 2½-ton M35 vehicle. For a complete terminal, telephone terminals AN/TCC-60 or AN/TCC-61 must be used with this set. Uses tropospheric scatter mode. (2 trucks, cargo, 2½-ton, 6 X 6 LWB).	Uses two radio sets AN/GRC-143 and 1 AN/GRC-106 (for alinement of tropo) and power unit PU-405. (TM 11-5820-602-15).
AN/TRC-138 radio repeater set	The AN/TRC-138 is a 48/96 channel radio repeater or a triple 48/96 channel radio terminal assemblage. Sufficient ancillary equipment is provided for a high capacity radio relay or radio terminal facility: (1 truck, cargo, 2½-ton, 6 X 6 LWB).	Uses three radio sets AN/GRC-144 and power unit PU-631 ()/G.
AN/TRC-139 radio terminal set	The radio terminal set AN/TRC-139 is a 48/96 channel combined radio and multiplex telephone terminal. It is intended for use in the area system where a requirement exists for 48 channel lateral trunks. (1 truck, cargo, 2½-ton, 6 X 6 LWB).	Uses three radio sets AN/GRC-144 and power unit PU-631()/G.
AN/TRC-140 radio terminal set	The radio terminal set AN/TRC-140 is a dual 48-channel combined radio and multiplex telephone terminal. It is intended for use in an area system to provide 48-channel trunking in two directions or 96-channel trunking in one direction. With backup radio. (1 truck, cargo, 2½-ton, 6 X 6 LWB).	Uses two radio sets AN/GRC-144 and power unit PU-631()/G.
AN/TRC-143 radio terminal set	Radio terminal set AN/TRC-143 is an air- or vehicular-transportable radio carrier assemblage used to provide terminal telephone multiplexing facilities 12-channel pulse code modulation for use by air-borne corps and corps artillery communications systems. (1 truck, cargo, 1¼-ton).	Uses radio set AN/GRC-50(V) 1 and power unit PU-626()/G.
AN/TRC-145 radio terminal set.	The AN/TRC-145 is a dual 6/12 channel combined radio/multiplex terminal assemblage. Sufficient ancillary equipment is provided for a complete low capacity dual radio/multiplex terminal. (1 truck, cargo, 1¼-ton).	Uses two radio sets AN/GRC-103 and power unit PU-625/G.
AN/GRC-68 radio relay repeater set.	The AN/GRC-68 is a radio relay repeater set, consisting of two basic radio sets AN/GRC-66 for a dual terminal repeater for 12/24 or 48/96 channels by appropriate pulse-code modulation multiplexers. Includes two masts AB-621, two 4½-ft diameter antennas and two 65-ft transmission lines. Operating frequency range is 4400-5000 MHz; planning range is 48 km (line of sight).	Uses receiver R-878 and transmitter T-681.
AN/GRC-103 radio relay set	The AN/GRC-103 is a forward area radio relay set intended to replace the AN/GRC-10, AN/TRC-27, and AN/TRC-24 in the forward areas. A complete 12-channel terminal, capable of being mounted in a ¼-ton, or two complete 12-channel terminals mounted in a ¾-ton shelter. Frequency range is 220 to 1000 MHz in 3 bands. Planning range is 32 km (line of sight).	Provides 1576 RF channels with 500 kHz channel spacing.
AN/GRC-143 radio relay set.	Radio set AN/GRC-143 is a compact, lightweight, 1-kilowatt tropospheric scatter radio relay set. It is used in conjunction with the pulse-code modulation multiplexer family of components to transmit up to 24 voice channels at ranges of 160 kilometers. Multihop systems may be established between two terminals. Operates in the 4400- to 5000-MHz frequency range. Used in extended range radio relay systems for the field army to provide long-haul point-to-point circuits.	Provides 600 RF channels. Is used by AN/TRC-112, AN/TRC-120, and AN/TRC-121.

Table 17. Major Components for New Army Communication System (AACOMS)—Continued

Equipment	Purpose and description	Remarks
AN/GRC-144 radio set.	Radio set AN/GRC-144 is a super high frequency (SHF), completely solid state radio which is intended for use in the high-traffic army area communications system (AACOMS). It provides, in conjunction with the 48- and 96-channel pulse-code modulation multiplex equipment, multichannel voice communication. This SHF set is an outgrowth of the tropo system, radio set AN/GRC-143. Frequency range is 4400-5000 MHz; planning range is 48 kilometers.	Main components are receiver R-1287, transmitter T-961, and mast AB-621.
AN/GRC-147 radio set.	The AN/GRC-147 provides for multichannel, line-of-sight, two-way radio communication in the super high frequency range of 4.4 to 5 GHz (1000 MHz = 1 GHz). It can handle up to 96 channels of data, using pulse-code modulation techniques, or up to 12 channels, using high frequency division multiplexing (FDM) techniques. An order wire channel is also provided in addition for service communication. Consists of three complete transmitters (T-1024/GRC) including wire, three complete receivers (R-878/GRC), and three antenna systems. This set is intended primarily for use as a radio relay station between two radio terminals of a communication network. The third receiver and transmitter are maintained in an operational standby condition and can be switched into the system on demand in the event of equipment failure to prevent interruption of service.	Used in AN/TRC-111 system. TM 11-5820-568-12. One complete receiving and transmitting system is maintained on a standby status when the set is used as a radio relay station.

APPENDIX D

JOINT COMMUNICATIONS-ELECTRONICS TYPE DESIGNATION SYSTEMS

1. Description of System and Use of Term Hertz

a. All Army, Navy, Air Force, and Marine Corps communication-electronics equipment may be identified by the nomenclature system described in figure 156. The letters "AN" appearing as the first two letters of the nomenclature are the system indicator and mean that the joint system was used in arriving at the term and that the item is a complete end item. The letters which follow the system indicator describe the installation, the

type of equipment, and the purpose of the equipment. The numbers which follow the letters indicate the model number of the equipment. Also see paragraph 222b, which discusses this system from a supply point of view.

b. The National Bureau of Standards has officially adopted the term "hertz (Hz)" for cycles per second. The chart below provides the equivalents of the unit/quantity terms and the list of approved abbreviations that will be used in technical manuals and other publications.

Unit/quantity	Old term	Old abbreviation	New term	New abbreviation
Frequency	Cycles per second	cps	hertz	Hz
10 ³ cycles per second	Kilocycles per second	kc	kilohertz	kHz
10 ⁶ cycles per second	Megacycles per second	Mc	megahertz	MHz
10 ⁹ cycles per second	Gigacycles per second	Gc	gigahertz	GHz

2. Component Indicators and Types of Emission

a. Table of Component Indicators

Component indicator	Family name	Examples
(Not be construed as limiting the application of the component indicator to these items.)		
AB	Support, antenna.....	Antenna mounts, mast bases, mast sections, towers, etc.
AM	Amplifier.....	Power, audio, interphone, radio-frequency, video servo (nonrotating), etc.
AS	Antenna assembly.....	Complex: arrays, parabolic type, masthead, etc.
AT	Antenna.....	Simple: whip or telescopic loop, dipole, reflector; also transducer, etc. (See H.)
BA	Battery, primary type.....	B-Batteries, battery packs, etc.
BB	Battery, secondary type.....	Storage batteries, battery packs, etc.
BZ	Signal device, audible.....	Buzzers, gongs, horns, etc.
C	Control article.....	Control box, remote tuning control, etc.
CA	Commutator assembly sonar.....	Peculiar to sonar equipment.
CB	Capacitor bank.....	Used as a power supply.
CG	Cable and transmission line, RF.....	RF cables, waveguides, etc., with terminals.
CK	Crystal kit.....	A kit of crystals with holders.
CM	Comparator.....	Analyzes or compares two or more input signals.
CN	Compensator.....	Electrical or mechanical compensating, regulating, or attenuating apparatus.
CP	Computer.....	A mechanical or electronic mathematical calculating device.
CR	Crystal.....	Crystal in crystal holder.
CU	Coupling device.....	Impedance coupling devices, directional couplers, etc.
CV	Converter (electrical).....	Electronic apparatus for changing the phase, frequency, or amplitude of the signal from one medium to another.

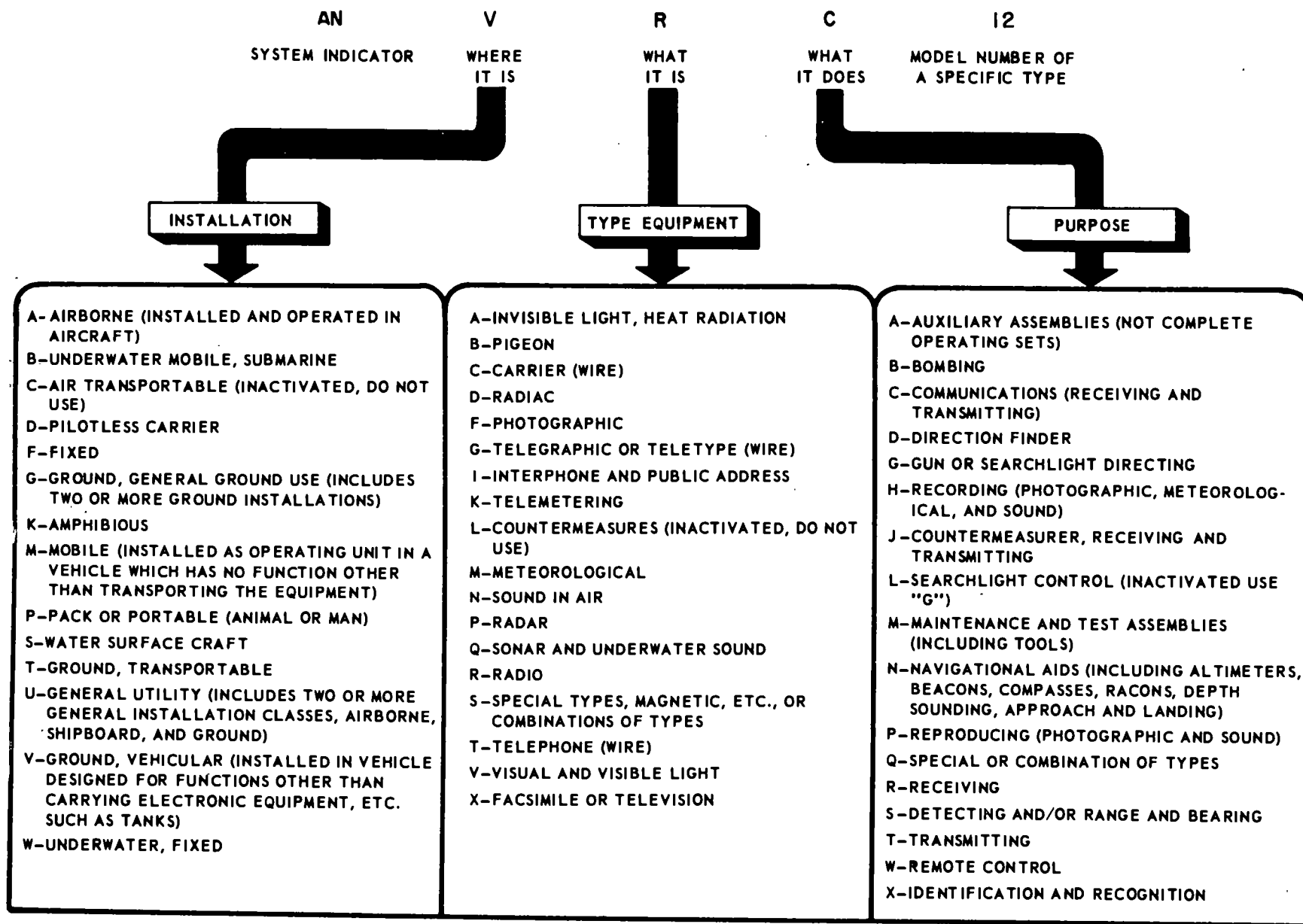


Figure 156. Joint communications-electronics type designation system.

<i>Component indicator</i>	<i>Family name</i>	<i>Examples</i>
CW	Cover.....	Cover, bag, roll, cap, radome, nacelle, etc.
CX	Cord.....	Cord with terminals; also composite cables of RF and non-RF conductors.
CY	Case.....	Rigid and semirigid structure for housing or carrying equipment.
DA	Antenna, dummy.....	RF test loads.
DT	Detecting head.....	Magnetic pickup device, search coil, hydrophone, etc.
DY	Dynamotor.....	Dynamotor power supply.
E	Hoist assembly.....	Sonar hoist assembly, etc.
F	Filter.....	Band-pass, noise, telephone, wave traps, etc.
FN	Furniture.....	Chairs, desks, tables, etc.
FR	Frequency-measuring device.....	Frequency meters, echo boxes, etc.
G	Generator.....	Electrical power generators without prime movers. (See PU and PD.)
GO	Goniometer.....	Goniometers of all types.
GP	Ground rod.....	Ground rods, stakes, etc.
H	Head, hand, and chest sets.....	Include earphone.
HC	Crystal holder.....	Crystal holder less crystal.
HD	Air-conditioning apparatus.....	Heating, cooling, dehumidifying, pressure, vacuum devices, etc.
ID	Indicating device.....	Calibrated dials and meters, indicating lights, etc. (See IP.)
IL	Insulator.....	Strain, standoff, feedthrough, etc.
IM	Intensity-measuring device.....	Includes standing wave ratio (SWR), gear, field intensity and noise meters, etc.
IP	Indicator, cathode-ray tube.....	Azimuth, elevation, plan position indicator (PPI), panoramic, etc.
J	Junction device.....	Junction, jack, and terminal boxes; connector panels, etc.
KY	Keying device.....	Mechanical, electrical, and electronic keyers, coders, interrupters, etc.
LC	Tool, line construction.....	Includes special apparatus such as cable plows.
LS	Loudspeaker.....	Separately housed loudspeakers.
M	Microphone.....	Radio, telephone, throat, hand, etc.
MD	Modulator.....	Device for varying amplitude, frequency, or phase.
ME	Meter, portable.....	Multimeters, volt-ohm-milliammeters, vacuum tube voltmeters, power meters, etc.
MK	Maintenance kit or equipment.....	Radio, telephone, general utility, etc.
ML	Meteorological device.....	Barometer, hygrometer, thermometer, scales, etc.
MT	Mounting.....	Mountings, racks, frames, stands, etc.
MX	Miscellaneous.....	Equipment not otherwise classified. (Do not use if better indicator is available.)
O	Oscillator.....	Master frequency, blocking, multivibrators, etc. (For test oscillators, see SG.)
OA	Operating assembly.....	Assembly of operating units not otherwise covered.
OC	Oceanographic device.....	Bathythermographs, etc.
OS	Oscilloscope, test.....	Test oscilloscopes for general test purposes.
PD	Prime driver.....	Gasoline engines, electric motors, diesel motors, etc.
PF	Fitting, pole.....	Cable hanger, clamp, protectors, etc.
PG	Pigeon article.....	Container, loft, vest, etc.
PP	Power supply.....	Nonrotating machine-type, such as vibrator pack, rectifier, thermoelectric.
PT	Plotting equipment.....	Except meteorological. Boards, maps, plotting table, etc.
PU	Power equipment.....	Rotating power equipment (except dynamotors), motor-generator, etc.
R	Receiver.....	All types of receiver except telephone.
RD	Recorder and reproducer.....	Tape, facsimile, disk, magnetic, etc.
RE	Relay assembly.....	Electrical, electronic, etc.
RF	Radio-frequency component.....	Composite component of RF circuits. (Do not use if better indicator is available.)
RG	Cable and transmission line, bulk RF.....	RF cable, waveguides, etc., without terminals.
RL	Reel assembly.....	Antenna, field wire, etc.
RP	Rope and twine.....	Nonelectrical cord, etc.
RR	Reflector.....	Target, confusion, etc., except antenna reflectors. (See AT.)
RT	Receiver and transmitter.....	Radio and radar transceivers, composite transmitter and receiver, etc.
S	Shelter.....	House, tent, protective shelter, etc.
SA	Switching device.....	Manual, impact, motor driven, pressure-operated, etc.
SB	Switchboard.....	Telephone, fire control, power, panel, etc.
SG	Generator, signal.....	Includes test oscillators and noise generators. (See O.)
SM	Simulator.....	Flight, aircraft, target, signal, etc.
SN	Synchronizer.....	Equipment to coordinate two or more functions.
ST	Strap.....	Harness, straps, etc.
T	Transmitter.....	All types of transmitters except telephone.
TA	Telephone apparatus.....	Miscellaneous telephone equipment.
TD	Timing device.....	Mechanical and electronic timing devices, range devices, multiplexers, electronic gates, etc.
TF	Transformer.....	Transformers when used as separate items.
TG	Positioning device.....	Tilt or train assemblies.
TH	Telegraph apparatus.....	Miscellaneous tool assemblies.
TK	Tool kit or equipment.....	Miscellaneous tool assemblies.

<i>Component indicator</i>	<i>Family name</i>	<i>Examples</i>
TL	Tool.....	All types except line construction. (See LC.)
TN	Tuning unit.....	Receiver, transmitter, antenna, etc.
TS	Test equipment.....	Test and measuring equipment.
TT	Teletypewriter and facsimile apparatus.....	Miscellaneous tape, teletype, facsimile equipment, etc.
TV	Tester, tube.....	Vacuum tube tester.
U	Connector, audio and power.....	Unions, plugs, sockets, adapters, etc.
UG	Connector, RF.....	Unions, plugs, sockets, choke couplings, adapters, elbows, flanges, etc.
V	Vehicle.....	Carts, dollies, trucks, trailers, etc.
VS	Signaling equipment, visual.....	Flag sets, air panels, signal lamp equipment, etc.
WD	Cable, two-conductor.....	Includes non-RF wire, cable, and cordage in bulk.
WF	Cable, four-conductor.....	Includes non-RF wire, cable, and cordage in bulk.
WM	Cable, multiple-conductor.....	Includes non-RF wire, cable, and cordage in bulk.
WS	Cable, single-conductor.....	Includes non-RF wire, cable, and cordage in bulk.
WT	Cable, three conductor.....	Includes non-RF wire, cable, and cordage in bulk.

b. Types of Emission.

<i>Type of modulation or emission</i>	<i>Type of transmission</i>	<i>Supplementary characteristics</i>	<i>Symbol</i>
1. Amplitude....	Absence of any modulation.....		A0
	Telegraphy without the use of modulating audio frequency (on-off keying).....		A1
	Telegraphy by the keying of a modulating audio frequency or frequencies or by the keying of the modulated emission. (Special case: an unkeyed modulated emission.).....		A2
	Telephony.....	Double sideband, full carrier.....	A3
		Single sideband, reduced carrier.....	A3a
		Two independent sidebands, reduced carrier..	A3b
	Facsimile.....		A4
	Television.....		A5
	Composite transmissions and cases not covered by the above.....		A9
	Composite transmissions.....	Reduced carrier.....	A9c
2. Frequency (or phase)	Absence of any modulation.....		F0
	Telegraphy without the use of modulating audio frequency (frequency-shift keying).....		F1
	Telegraphy by the keying of a modulating audio frequency or frequencies or by the keying of the modulated emission. (Special case: an unkeyed emission modulated by audio frequency.).....		F2
	Telephony.....		F3
	Facsimile.....		F4
	Television.....		F5
	Composite transmissions and cases not covered by the above.....		F9
3. Pulsed emissions	Absence of any modulation intended to carry information.....		P0
	Telegraphy without the use of modulating audio frequency.....		P1
	Telegraphy by the keying of a modulating audio frequency or frequencies or by the keying of the modulated pulse. (Special case: an unkeyed modulated pulse.).....	Audio frequency or frequencies modulating the amplitude of the pulse.	P2d
		Audio frequency or frequencies modulating the width of the pulse.	P2e
		Audio frequency or frequencies modulating the phase or position of the pulse.	P2f
	Telephony.....	Amplitude modulated pulse.....	P3d
		Width modulated pulse.....	P3e
		Phase or position modulated pulse.....	P3f
	Composite transmissions and cases not covered by the above.....		P9

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By Order of the Secretary of the Army:

Official:

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Major General, United States Army,
The Adjutant General.

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

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GUIDE TO SELECTION OF STANDARD RF CABLES

49-2B

28 JULY 1954

Class of cable	JAN type	Inner conductor	Dielectric material	Nominal diameter of dielectric	Shielding braid	Protective covering	Nominal overall diameter	Weight	Approximate impedance	Nominal capacitance	Maximum operating voltage	Remarks
General purpose	RG-58/U	16 AWG silvered copper	A	Inch 0.181	Silver-coated copper, double braid	Noncontaminating synthetic resin	Inch 0.328	Lb/ft 0.093	Ohms 50.0	μμf/ft 28.5	Volts(rms) 3,000	Small size, microwave cable
	RG-6A/U	21 AWG copper-covered steel	A	0.185	Inner-silver-coated copper; Outer-copper	Noncontaminating synthetic resin	0.332	---	76.0	20.0	2,700	Small size, video and communication cable
	*RG-8A/U	7/21 AWG copper	A	0.285	Copper, single braid	Synthetic resin	0.405	0.120	50.0	29.5	4,000	Medium size, flexible cable
	*RG-9B/U	7/21 AWG silvered copper	A	0.280	Silver-coated copper, double braid	Noncontaminating synthetic resin	0.420	0.158	50.0	30.0	4,000	Special, medium size, flexible cable
	*RG-10A/U	7/21 AWG copper	A	0.285	Copper, single braid	Noncontaminating synthetic resin and armor	0.475 max.	0.160	50.0	29.5	4,000	Same as RG-8A/U but with armor
	*RG-11A/U	7/26 AWG tinned copper	A	0.285	Copper, single braid	Synthetic resin	0.405	---	75.0	20.5	4,000	Medium size, flexible video and communication cable
	*RG-12A/U	7/26 AWG tinned copper	A	0.285	Copper, single braid	Noncontaminating synthetic resin with armor	0.475 max.	---	75.0	20.5	4,000	Similar to RG-11A/U but with armor
	*RG-13A/U	7/26 AWG tinned copper	A	0.280	Copper, double braid	Synthetic resin	0.420	---	74.0	20.5	4,000	Medium size, flexible, video and communication cable
	*RG-14A/U	10 AWG copper	A	0.370	Copper, double braid	Noncontaminating synthetic resin	0.545	0.236	50.0	29.5	5,500	Medium size, power transmission cable
	*RG-17A/U	0.188-inch copper	A	0.680	Copper, single braid	Noncontaminating synthetic resin	0.870	0.491	50.0	29.5	11,000	Large size, low attenuation, high power transmission cable
	*RG-18A/U	0.188-inch copper	A	0.680	Copper, single braid	Noncontaminating synthetic resin and armor	0.945 max.	0.603	50.0	29.5	11,000	Same as RG-17A/U but with armor
	RG-19A/U	0.250-inch copper	A	0.910	Copper, single braid	Noncontaminating synthetic resin	1.120	0.745	50.0	29.5	14,000	Very large, low attenuation, high power transmission cable
	RG-20A/U	0.250-inch copper	A	0.910	Copper, single braid	Noncontaminating synthetic resin and armor	1.195 max.	0.925	50.0	29.5	14,000	Same as RG-19A/U but with armor
	RG-34A/U	7/21 AWG copper	A	0.455	Copper, single braid	Noncontaminating synthetic resin	0.625	0.231	71.0	21.5	5,200	Large size, high power, low attenuation, flexible cable
	RG-35A/U	9 AWG copper	A	0.680	Copper, single braid	Noncontaminating synthetic resin and armor	0.945 max.	0.480	71.0	21.5	10,000	Large size, high power, low attenuation, video and communication cable
	RG-55/U	20 AWG copper	A	0.116	Tinned copper, double braid	Polyethylene	0.206 max.	0.032	50.0	28.5	1,900	Small size, flexible cable
	*RG-58C/U	19/0.0066-inch tinned copper	A	0.116	Tinned copper, single braid	Noncontaminating synthetic resin	0.195	0.029	50.0	28.5	1,900	Small size, flexible cable
	RG-59A/U	22 AWG copper-covered steel	A	0.146	Copper, single braid	Noncontaminating synthetic resin	0.242	---	73.0	21.0	2,300	General purpose, small size, video cable
	*RG-74A/U	10 AWG copper	A	0.370	Copper, double braid	Noncontaminating synthetic resin and armor	0.615 max.	0.282	50.0	29.5	5,500	Same as RG-14A/U but with armor
	RG-84A/U	9 AWG copper	A	0.680	Copper, single braid	Noncontaminating synthetic resin with lead sheath	1.000	1.325	71.0	21.5	10,000	Same as RG-35/U except lead sheath instead of armor for subterranean installations
	*RG-85A/U	9 AWG copper	A	0.680	Copper, single braid	Noncontaminating synthetic resin with lead sheath and special armor	1.565 max.	2.910	71.0	21.5	10,000	Same as RG-84A/U with special armor for subterranean installations
High temperature	RG-87A/U	7/20 AWG silvered copper	F (solid)	0.280	Silver-coated copper, double braid	Teflon-tape moisture seal, two braids fiberglass, silicone-varnish impregnated	0.425	0.176	50.0	29.5	4,000	Semi-flexible cable, operating at temperatures -55° to 250° C
	*RG-116/U	7/20 AWG silvered copper	F (solid)	0.280	Silver-coated copper, double braid	Teflon-tape moisture seal, two braids fiberglass, silicone-varnish impregnated and armor	0.475	0.224	50.0	29.5	4,000	Same as RG-87A/U but with armor
	RG-117/U	0.188-inch copper	F (solid)	0.620	Copper, single braid	Teflon-tape moisture seal, two braids fiberglass, silicone-varnish impregnated	0.730	0.450	50.0	29.0	5,000	Semi-flexible cable, operating at temperatures -55° to 250° C
	*RG-118/U	0.188-inch copper	F (solid)	0.620	Copper, single braid	Teflon-tape moisture seal, two braids fiberglass, silicone-varnish impregnated and armor	0.780	0.600	50.0	29.0	5,000	Same as RG-117/U but with armor
	RG-140/U	21 AWG silver-coated, copper-covered steel	F	0.146	Silver-coated copper, single braid	Teflon-tape moisture seal, single fiberglass braid, silicone-varnish impregnated	0.241	0.045	73.0	21.0	2,300	Similar to RG-59/U, except cable core is teflon
	RG-141/U	19 AWG silver-coated, copper-covered steel	F	0.116	Silver-coated copper, single braid	Teflon-tape moisture seal, single fiberglass braid, silicone-varnish impregnated	0.195	0.030	50.0	28.5	1,900	Similar to RG-58/U, except cable core is teflon
	RG-142/U	19 AWG silver-coated, copper-covered steel	F	0.116	Silver-coated copper, double braid	Teflon-tape moisture seal, single fiberglass braid, silicone-varnish impregnated	0.206	0.045	53.5	28.5	1,900	Similar to RG-55/U, except cable core is teflon
	RG-143/U	15 AWG silver-coated, copper-covered steel	F	0.185	Silver-coated copper, double braid	Teflon-tape moisture seal, double fiberglass braid, silicone-varnish impregnated	0.322	0.102	50.0	28.5	3,000	Similar to RG-5/U, except cable core is teflon
	RG-144/U	7/25 AWG silver-coated, copper-covered steel	F	0.285	Silver-coated copper, single braid	Teflon-tape moisture seal, double fiberglass braid, silicone-varnish impregnated	0.405	0.120	75.0	20.5	4,000	Similar to RG-11/U, except cable core is teflon
	RG-146/U	33 AWG copper-covered steel	F	0.285	Copper, single braid	Teflon-tape moisture seal, fiberglass braid, silicone-varnish impregnated	0.375	---	185.0	6.5	1,000	Small size coaxial cable similar to RG-114A/U except for high temperature
Pulse 3	RG-25/U	19/0.0117-inch tinned copper	O	0.308	Tinned copper, double braid	Chloroprene	0.565	0.205	50.0	50.0	8,000 peak	Special cable for twist application
	*RG-25A/U	19/0.0117-inch tinned copper	E	0.308	Tinned copper, double braid	Chloroprene	0.505	0.205	50.0	50.0	8,000	High voltage cable
	RG-26/U	19/0.0117-inch tinned copper	D	0.308	Tinned copper, single braid	Chloroprene with armor	0.525 max.	0.189	50.0	50.0	8,000 peak	Medium size cable
	*RG-26A/U	19/0.0117-inch tinned copper	E	0.288	Tinned copper, single braid	Chloroprene with armor	0.505	0.189	50.0	50.0	8,000	High voltage cable
	*RG-27/U	19/0.0185-inch tinned copper	O	0.455	Tinned copper, single braid	Synthetic resin and armor	0.675 max.	0.304	50.0	50.0	15,000 peak	Large size cable
	RG-28/U	19/0.0185-inch tinned copper	D	0.455	Inner-tinned copper; Outer-galvanized steel	Chloroprene	0.805	0.370	50.0	50.0	15,000 peak	Large size cable
	*RG-64A/U	19/0.0117-inch tinned copper	E	0.288	Tinned copper, double braid	Chloroprene	0.475	0.205	50.0	50.0	8,000	Medium size cable
	*RG-88A/U	19/0.0117-inch tinned copper	E	0.288	Tinned copper, four braids	Noncontaminating synthetic resin	0.490 max.	---	50.0	50.0	8,000	Replaces RG-77/U in aircraft applications
	*RG-21A/U	16 AWG resistance wire	A	0.185	Silver-coated copper, double braid	Noncontaminating synthetic resin	0.332	0.093	53.0	29.0	2,700	Special high attenuation cable with small temperature coefficient of attenuation
Special characteristics	RG-22B/U	Two conductors 7/0.0152-inch copper	A	0.285	Tinned copper, double braid	Noncontaminating synthetic resin	0.420	0.116	95.0	16.0	1,000	Small size, balanced, twin conductor cable
	RG-62A/U	22 AWG solid copperweld	A-2	0.146	Copper, single braid	Synthetic resin	0.242	0.382	93.0	13.5	750	Similar to RG-62/U except for jacket material
	RG-62B/U	7/32 AWG copper-covered steel	A	0.146	Copper, single braid	Noncontaminating synthetic resin	0.242	0.040	93.0	13.5	750	Same as RG-62A/U except inner conductor is stranded
	*RG-63B/U	22 AWG copper-covered steel	A	0.285	Copper, single braid	Noncontaminating synthetic resin	0.405	0.082	125.0	10.0	1,000	Medium size, low capacitance air-spaced cable
	*RG-65A/U	No. 32 formex, F, 0.128-inch diameter (Helix)	A	0.285	Copper, single braid	Noncontaminating synthetic resin	0.405	0.096	950.0	44.0	1,000	High impedance video cable, high delay line
	*RG-71A/U	22 AWG copper-covered steel	A	0.146	Tinned copper, double braid	Synthetic resin	0.250 max.	0.046	93.0	13.5	750	Small size, low capacitance, air-spaced cable
	*RG-79B/U	22 AWG copper-covered steel	A	0.285	Copper, single braid	Noncontaminating synthetic resin	0.475 max.	0.138	125.0	10.0	1,000	Same as RG-63B/U but with armor
	RG-86/U	Two conductors 7/0.0285-inch copper	A	0.285	None	None	0.285 max. 0.650	---	200.0	---	---	For rhombic and doublet receiving antennas
	RG-111A/U	Each conductor 7/0.0152-inch copper	A	0.285	Tinned copper, double braid	Noncontaminating synthetic resin and armor	0.490 max.	0.145	95.0	16.0	1,000	Same as RG-22B/U but with armor
	RG-126/U	7/24 AWG Karma wire	F	0.180	Karma wire single braid	Teflon-tape moisture seal, two braids fiberglass, silicone-varnish impregnated	0.275	0.076	50.0	29.0	3,000	High attenuation cable
	RG-130/U	Each conductor .0285-inch; 7 strands plain copper wire	A	0.472	Tinned copper, single braid	Synthetic resin	0.625	0.220	95.0	17.0	8,000	Same as RG-57/U, except inner conductors are twisted to improve flexibility
	RG-131/U	Each conductor .0285-inch; 7 strands plain copper wire	A	0.472	Tinned copper, single braid	Synthetic resin with aluminum armor	0.710	0.295	95.0	17.0	8,000	Same as RG-130/U but with armor

Figure 11-1. Standard coaxial cables.

NOTES:

1/ DIELECTRIC MATERIALS:

A-STABILIZED POLYETHYLENE

O-LAYER OF SYNTHETIC RUBBER BETWEEN TWO LAYERS OF CONDUCTING RUBBER

E-LAYER OF CONDUCTING RUBBER PLUS TWO LAYERS OF SYNTHETIC RUBBER

F-POLYTETRAFLUOROETHYLENE (TEFLON)

G-MAGNESIUM OXIDE

2/ SEE INDIVIDUAL SPECIFICATIONS FOR NOMINAL IMPEDANCES AND ALLOWABLE TOLERANCES.

3/ IN PULSE CABLE, THE NOMINAL DIAMETER OF DIELECTRIC TO THE DIAMETER OVER THE OUTER LAYER OF CONDUCTING OR SYNTHETIC RUBBER

* THESE CABLES ARE PREFERRED FOR NAVY APPLICATIONS

TM48-519

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